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Alexandria, VA 22310-3398

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Underground Technology Program
Test Adit Construction

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Technical Report

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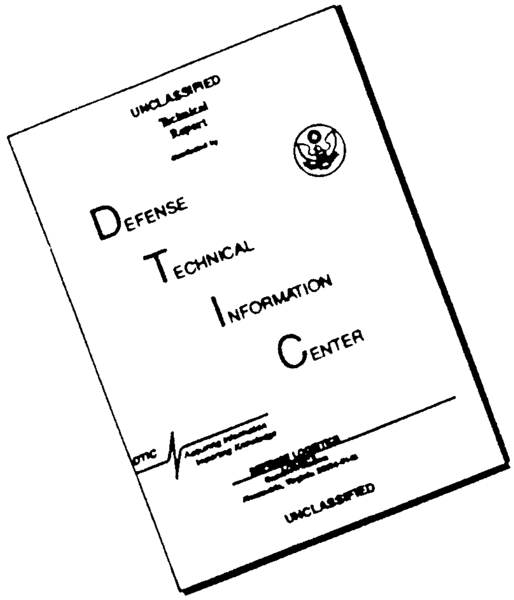

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This report describes the geotechnical investigation, design and construction of a test adit which was built to support the Defense Special Weapons Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.

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SUMMARY

This report describes the geotechnical investigation, design, and construction of a test adit which was built to support the Defense Nuclear Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.

The geotechnical investigation includes preconstruction geologic exploration, geologic mapping, gas detection, and soil and rock hydrology. The information provided is also the result of on-site inspection, quality control review, and instrumentation of ground support areas, all performed during the course of construction.

The contractor's methods of construction are also examined, as are the remedial methods taken when methane gas was encountered during the course of construction.

PREFACE

This report documents work performed as part of the DNA Underground Technology Program, and was funded under contract DNA001-92-C-0051. The DNA Project Managers were Major Curt Krieser and Paul Senseny. The Army Corps of Engineers, Louisville District, inspectors were Mr. Tony Hamblin and Mr. Steve Duncan. The Waterways Experiment Station (WES) Site Manager was Mr. David Ward.

For Lachel and Associates: Mr. James E. Beck was in charge of overall project management; Mr. Lawrence Eckert and Mr. Ghailan Alsayab provided the geologic and tunnel engine-ring field work; Mr. Dennis Lachel and.Mr. Rich Linamen provided the off-site tunnel engineering support; and Mr. Gunnar J. Radel reviewed and edited the final report.

Detailed information on the preconstruction geologic explorations and investigations can be found in Volumes 2 and 3 of the "Solicitation for Underground Technology Program, Test Adit Construction, 1992" which contains the Geotechnical Design Summary Report prepared by Lachel and Associates.

CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY ——→ BY ——→ TO GET
TO GET ←—— BY ←—— DIVIDE

angstrom	1.000 000 X E -10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn	1.000 000 X E -28	meter^2 (m^2)
British thermal unit (thermochemical)	1.054 350 X E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm^2)	4.184 000 X E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 X E +1	*giga becquerel (GBq)
degree (angle)	1.745 329 X E -2	radian (rad)
degree Fahrenheit	$t_k = (t^\circ f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 X E -19	joule (J)
erg	1.000 000 X E -7	joule (J)
erg/second	1.000 000 X E -7	watt (W)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	meter^3 (m^3)
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)
kip/inch^2 (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktap	1.000 000 X E +2	newton-second/m^2 (N-s/m^2)
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 X E -1	newton-meter (N·m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/foot^2	4.788 026 X E -2	kilo pascal (kPa)
pound-force/inch^2 (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214 011 X E -2	kilogram-meter^2 (kg·m^2)
pound-mass/foot^3	1.601 846 X E +1	kilogram/meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000 000 X E -2	**Gray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -8	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (mm Hg, 0° C)	1.333 22 X E -1	kilo pascal (kPa)

*The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.
**The Gray (GY) is the SI unit of absorbed radiation.

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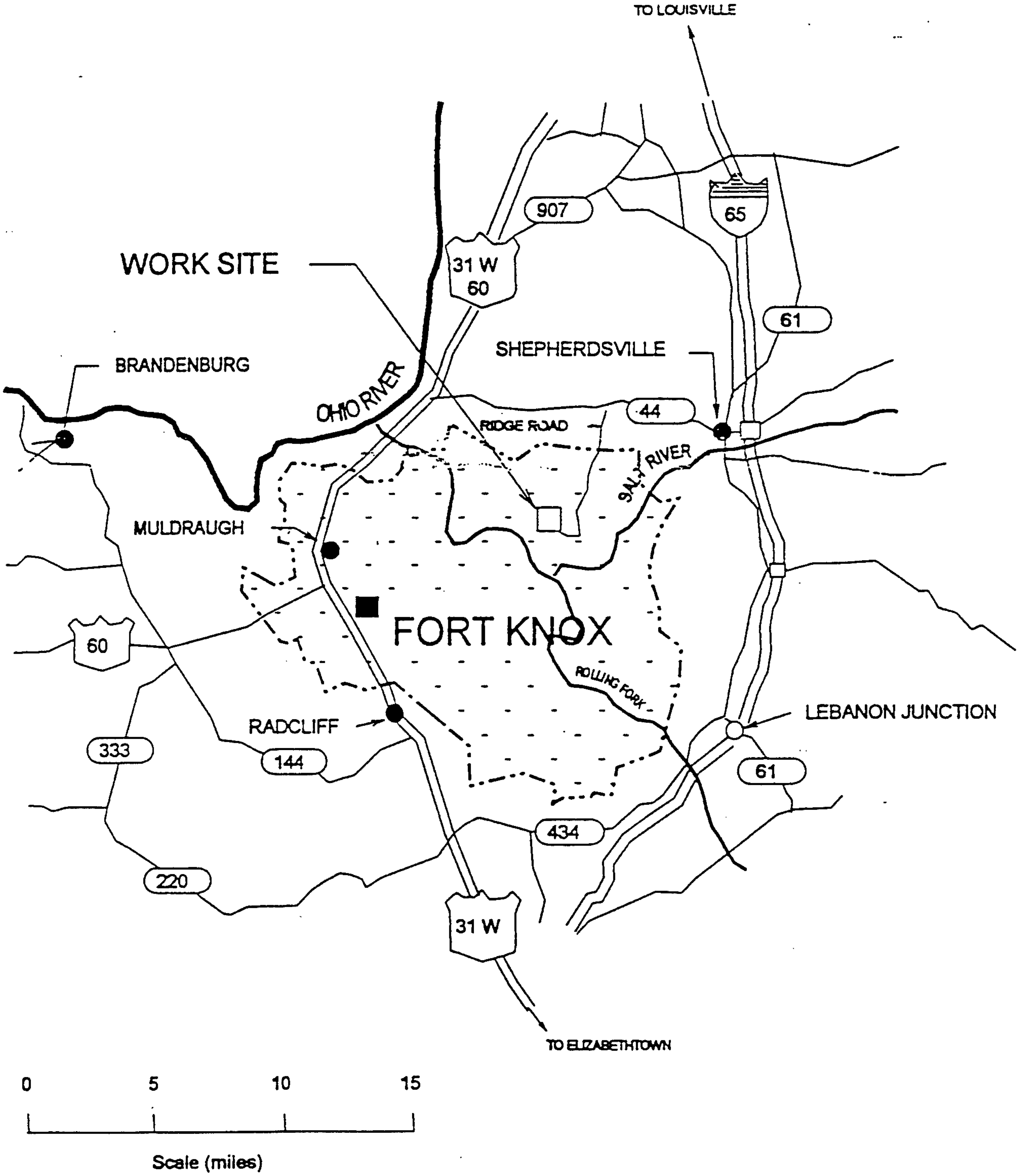

Figure 1-1. Location Map.

SECTION 1

INTRODUCTION

1.1 UNDERGROUND TECHNOLOGY PROGRAM.

The Underground Technology Program (UTP) is a part of the Government's continuing research to evaluate the lethality effects of dynamic loads on underground structures, and to develop a high-confidence method for predicting these effects. This method is being developed through both theoretical and analytical activities, combined with field tests and experimental activities. This research is sponsored by the Defense Nuclear Agency (DNA).

1.2 TEST ADIT CONSTRUCTION.

As part of the overall Underground Technology Program, DNA is developing an underground high explosive test bed at the Rodgers Hollow Area, Fort Knox, Kentucky, to support field tests and experimental activities. The test adit construction contract is the first phase in developing the test bed. Rodgers Hollow is located on the Fort Knox Military Reservation approximately 7.4 miles west-southwest of Shepherdsville, Kentucky, in Bullitt County. The Rodgers Hollow geographic coordinates are 37^{0} 56' 57.40308" North and 85^{0} 50' 34.56814" West at an elevation approximately 490 feet above mean sea level (MSL). The site location plan is shown in Figure 1-1.

The test adit was constructed by W. L. Hailey and Company, Inc. of Nashville, Tennessee under U.S. Army Corps of Engineers contract DACA27-92-R-0003 administered by the U.S. Army Corps of Engineers, Louisville District. LACHEL and Associates, Inc. of Golden, Colorado performed the tunnel design, prepared the contract drawings and specifications, and provided onsite geotechnical assistance during the construction period. The U.S. Army Corps of Engineers Waterways Experimental Station (WES) provided overall program management for the UTP and site management of the Rodgers Hollow test site.

1.3 REPORT ORGANIZATION.

This report is divided into six sections and appendices. This introduction (Section 1) is followed by a description of the test adit construction project (Section 2) and changes to the original adit design. Section 3 describes the geology and hydrology of the Rodgers Hollow site. Section 4 describes construction methods and

production rates. Section 5 describes the tunnel instrumentation, and Section 6 is a list of references. The Appendices A through D contain the geologic core logs, rock test results, geologic maps, and photographs, respectively.

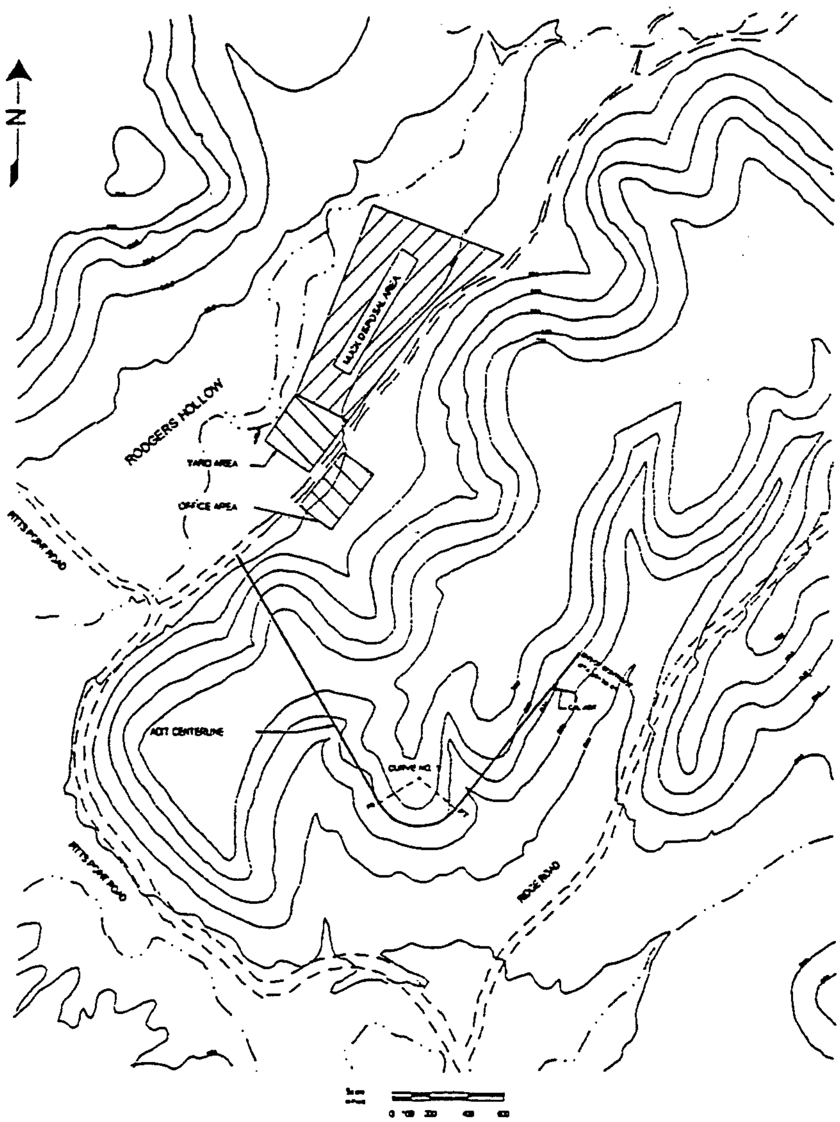

Figure 2-1. Project Site Plan.

SECTION 2

PROJECT DESCRIPTION

2.1 GENERAL.

The UTP Test Adit Construction contract was designed to provide access to the test bed located in the Louisville Formation, approximately 300 feet below the floor of Rodgers Hollow. The major items of work required by the contract included surface site work, one flood protection structure, 36 feet of cut-and-cover portal structure, 3,035 feet of 12 foot by 12 foot adit, 100 feet of 8 foot by 8 foot adit, four enlargements in tunnel cross section, and electrical, ventilation and dewatering systems.

A Request for Proposals (RFP) was issued in May, 1992, which required the submission of a two-part proposal, Technical and Cost, in separate envelopes. The cost proposal was a firm fixed price based on contractor developed unit prices for a schedule of bid items included in the RFP. The proposals were evaluated first on technical merit, and then on cost. A total of ten proposals were received in June, 1992, ranging in value from a low of $3.8 million to a high of $8.0 million. After evaluating the Technical Proposals, establishing a competitive range, and determining the most advantageous proposal to the Government, a contract was awarded to W. L. Hailey & Co., Inc. in July 1992, for an approximate value of $4,665,000.

2.2 AS-BID PROJECT CONFIGURATION.

2.2.1 Site Work.

As part of the test adit construction, the contractor was required to provide and upgrade surface site facilities. Included in this item are the upgrading of the gravel road in Rodgers Hollow, providing office trailers, parking areas, contractor's laydown areas, clearing and grubbing for the portal, muck disposal, the installation of sediment control tanks, and 6,800 feet of surface discharge water line. Figure 2-1 shows the original site layout. Also included in this item of work was the providing of normal site services and maintenance such as furnishing potable water, sewage disposal, trash removal, guard service, the cleaning of offices and yard areas, and the supply and distribution of electrical power on surface.

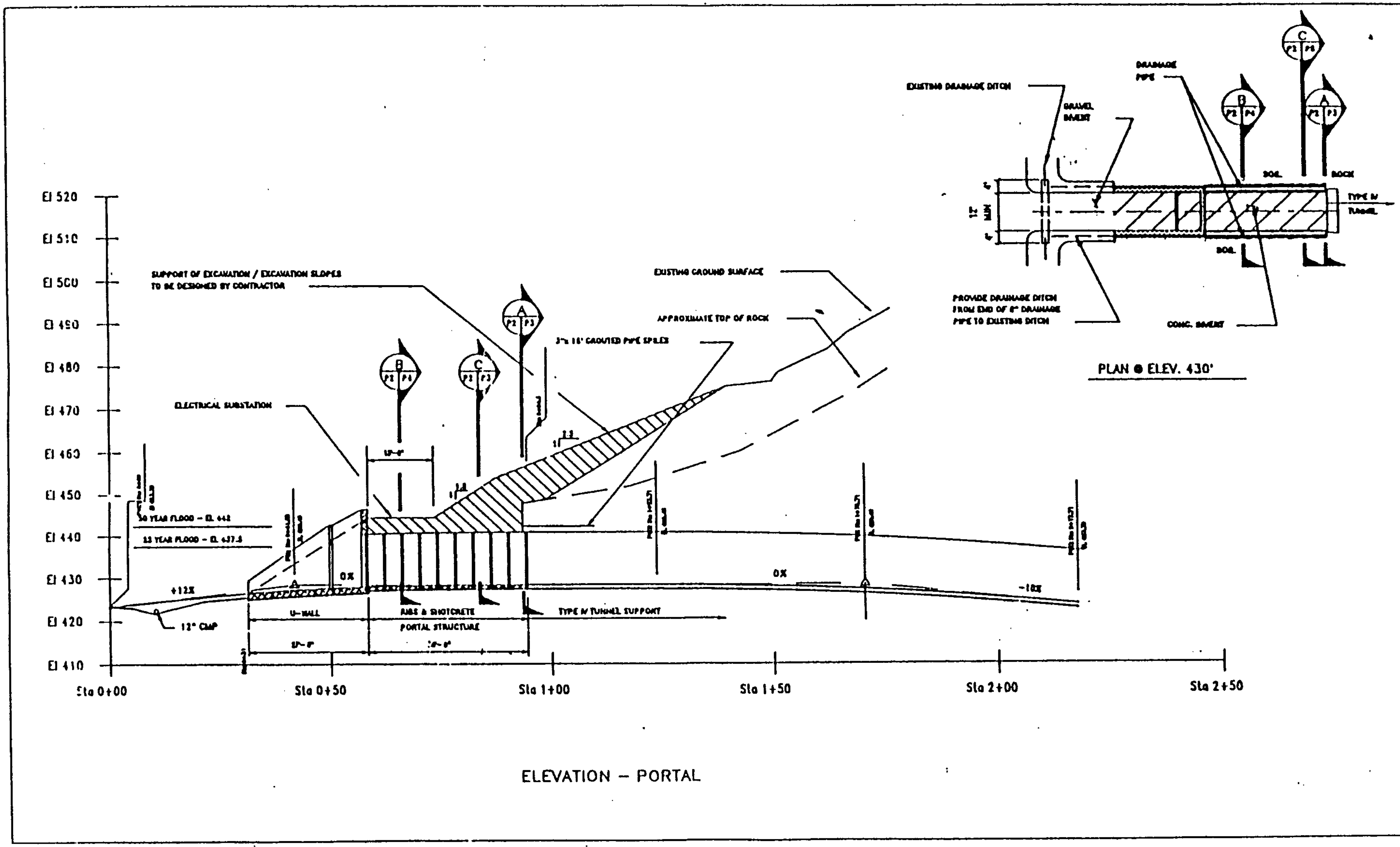

Figure 2-2. Portal Construction.

2.2.2 Portal Structures .

The portal to the test adit is comprised of two sections, a flood protection structure, and a cut-and-cover tunnel section, as shown in Figure 2-2 opposite. The flood protection structure, from Station 0+31 to Station 0+58, is a U-shaped reinforced concrete structure with removable timber stop logs (shown on Figure 2-3 on the next page). During normal operation of the site, the stop logs are removed and the structure provides unimpeded access to the portal. During flood events of the Salt River basin, the stop logs are installed in the cast-in-place guides, and an temporary earth dike is constructed in front of the stop logs to provide flood protection for the tunnel adit for a 50 year flood. When the stop logs are in place, access to the tunnel for both men and tunnel utilities is provided via the open area between the stop logs and the concrete portal at Station 0+58.

The cut-and-cover portal structure, from Station 0+58 to Station 0+94, consists of a 6 inch thick wire reinforced shotcrete with horseshoe shaped, steel arch sections (W6x25s) 4 feet on center and a 1 foot thick reinforced concrete slab at the tunnel invert. The outside of the structure is coated with an asphaltic dampproofing. A 6 inch perforated drain pipe is provided at the base of the wall on either side to prevent surface water from entering the tunnel. Figure 2-4, which follows, provides details of the structure. The portal was constructed in an open cut in the side of the hill and backfilled with structural material prior to commencing tunneling operations.

2.2.3. MAIN ADIT .

The main adit consists of 2,935 feet of 12 foot wide by 13 foot high, straight legged, horseshoe-shaped tunnel which commences at Station 0+94 and progresses downgrade on a 10 per cent slope to Station 30+29. It penetrates completely through the New Providence and New Albany Shales and terminates in the middle of the Louisville Formation, 286 feet below the portal elevation and approximately 458 feet below the top of the hill (see Figure 2-5 on page 9). The main adit alignment consists of two tangent sections, at bearings S31°06′53"E and N39°18′46"E, and a 250 foot radius curve.

A total of four widened areas or bays were required to be excavated within the main adit. The tunnel width increased to 17 feet in the bay areas to accommodate permanent electrical and mechanical equipment. Two of these bays were for electrical transformers and circuit panels, which are located at Station 15+00 and Station 29+73, and offset to the right of tunnel centerline. The other two bays contain dewatering sump boxes and pumps and are located at Station 14+56 and Station 30+17, and are offset to the left of the

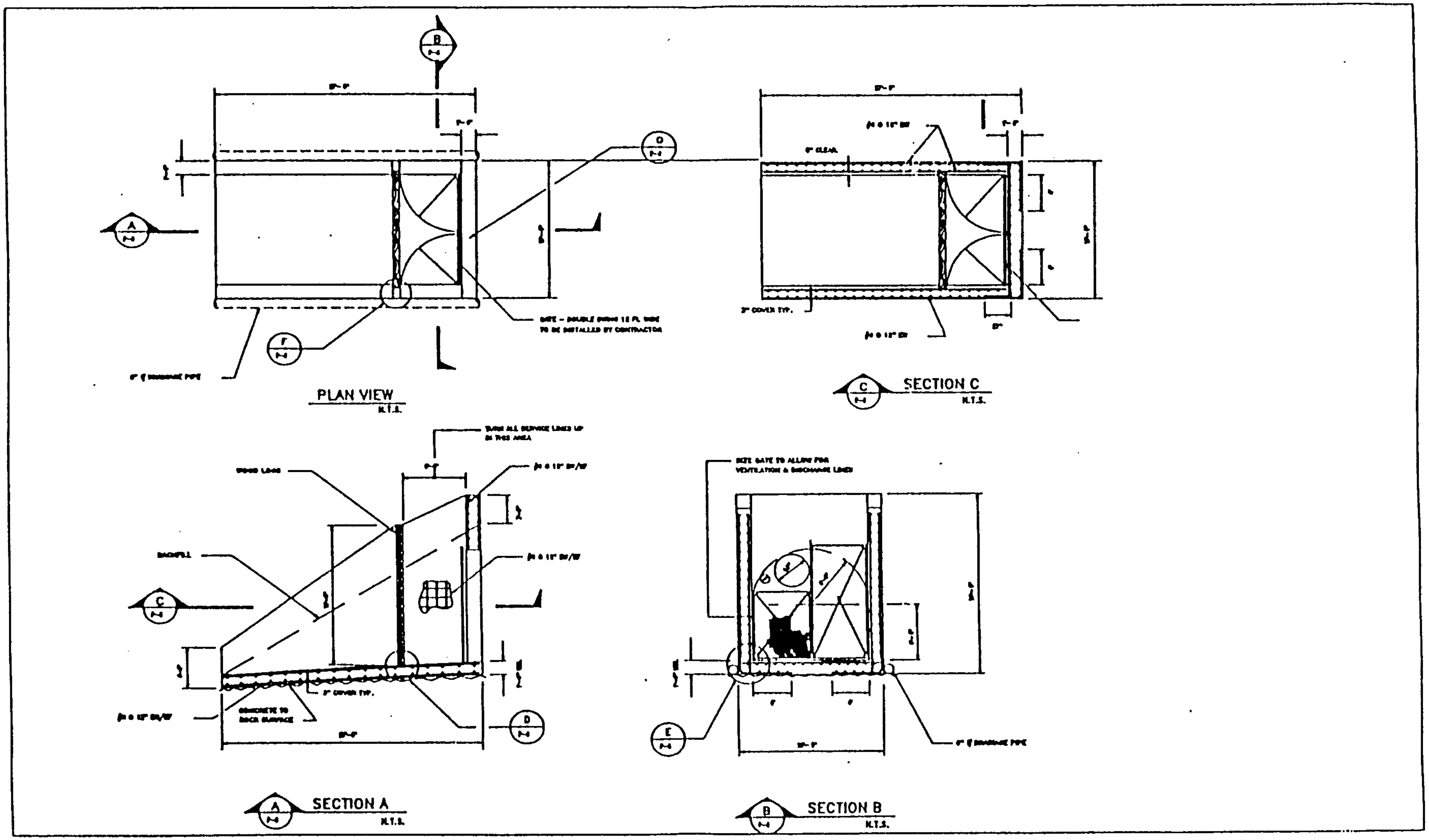

Figure 2-3. Portal U-Wall.

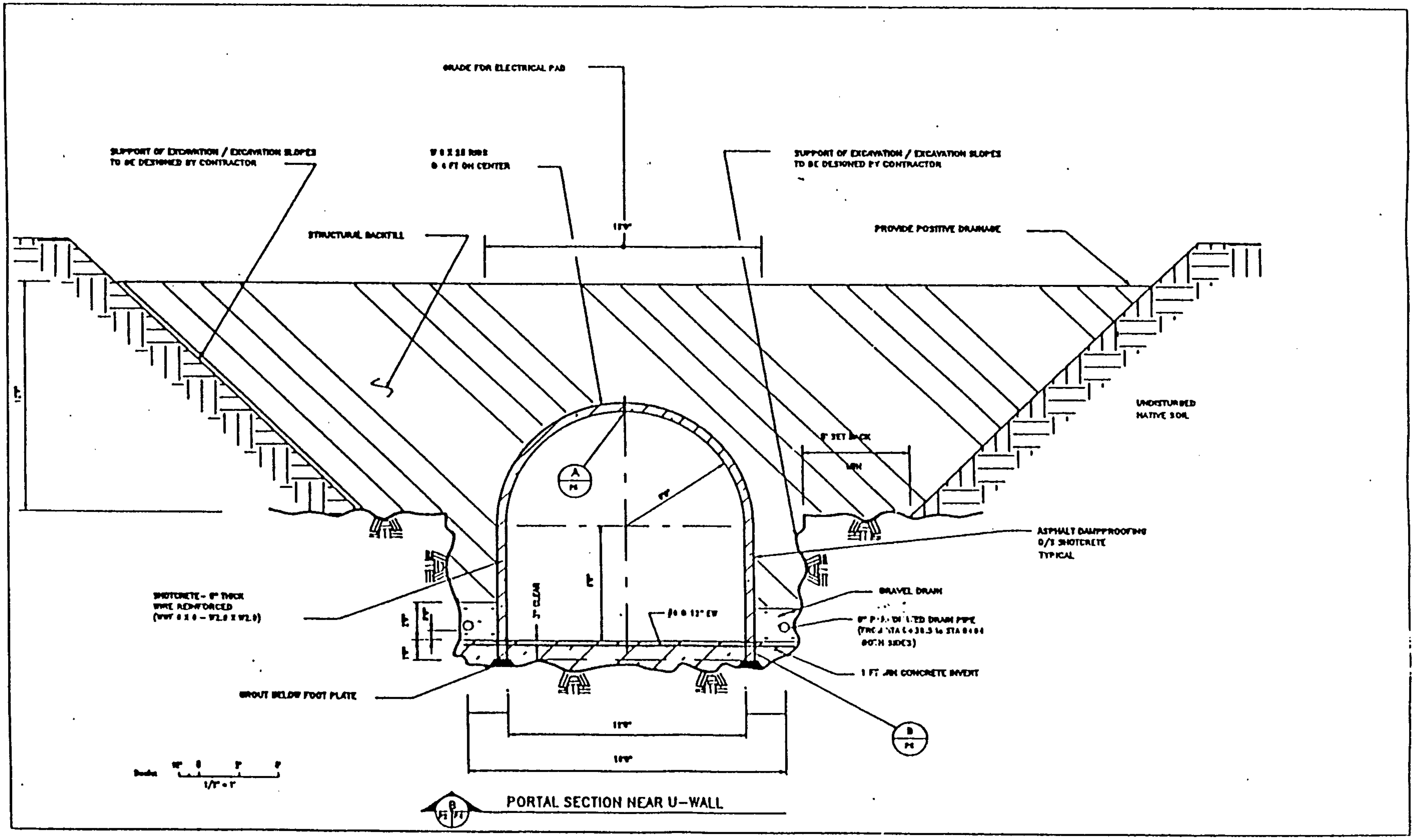

Figure 2-4. Portal Section.

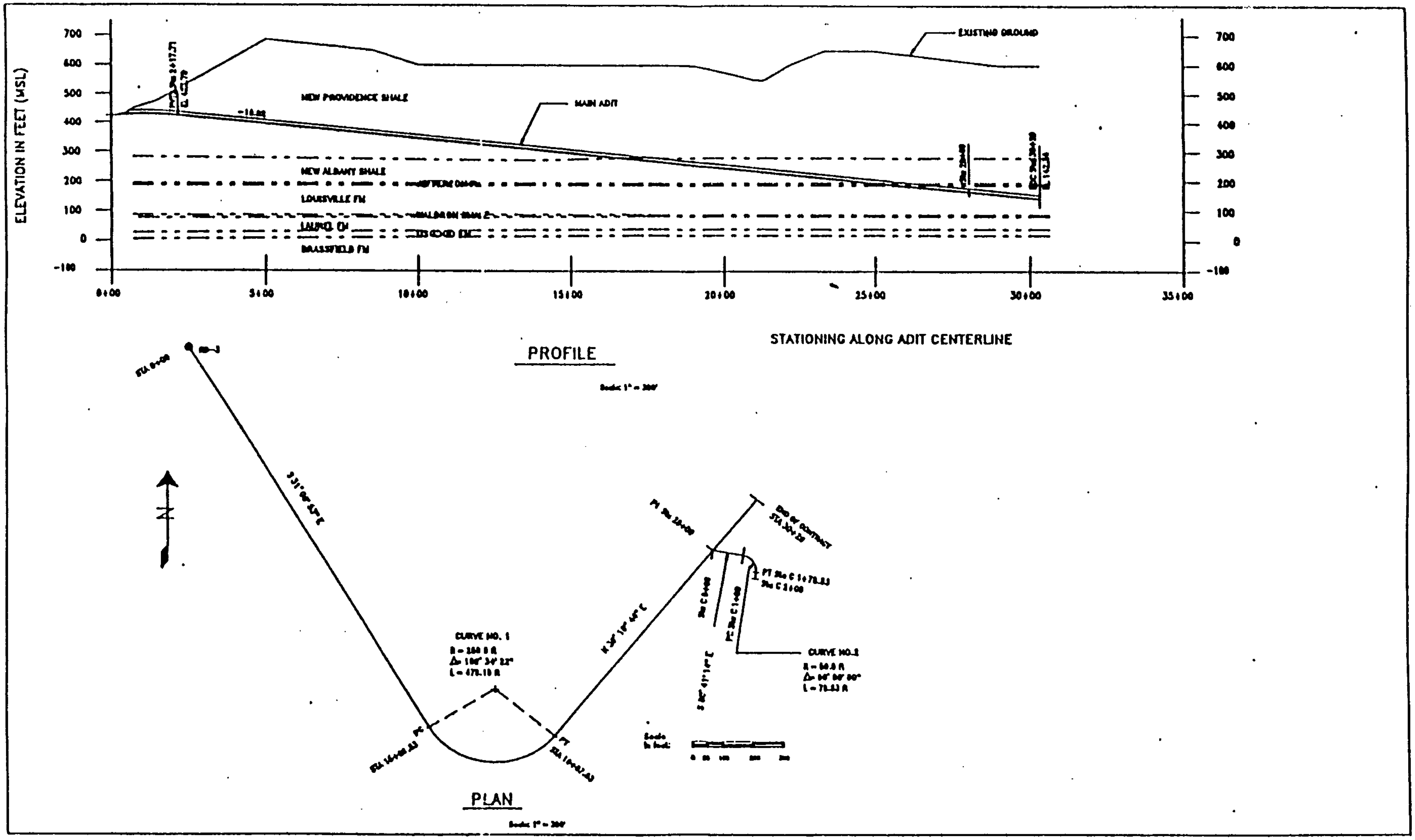

Figure 2-5. As-Bid Plan & Profile.

tunnel centerline. The design configuration of the main adit included a 12 inch thick gravel invert and a permanent lining of 2 inches of shotcrete in the shale formations, and chain link fabric in the top 120° of the crown in the limestone formations.

2.2.4 Calibration Adit and Drift.

The calibration adit forms a Y-intersection with the main adit at Station 28+00 and progresses on a S80°41'14"E bearing away from the main adit. This adit is a 12 foot wide by 13 foot high tunnel similar in cross section and configuration to the main adit and extends from Station C 0+00 to C 1+00. At Station C 1+00, the cross section reduces to an 8 foot wide by 8 foot high drift which continues to the termination of the drift at Station C 2+00. The drift is not lined with shotcrete or chain link fabric, nor does it have a gravel invert.

2.2.5 Ground Support.

The design of the permanent tunnel support was based on data obtained through the geotechnical explorations conducted at the site as detailed in Section II of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) included in Vol. 2 of the "Solicitation for the Underground Technology Program Test Adit Construction", and summarized in Section 3 of this report. The primary basis for the design of tunnel support was the Norwegian Geotechnical Institute (NGI) Q-system which is a quantitative design method based on the evaluation of hundreds of tunnels. The method considers a variety of parameters that are known to affect tunnel stability.

The initial ground support calculations, based on the data obtained during the geotechnical investigation, indicated that the formations to be excavated (the New Providence Shale, the New Albany Shale, and the Louisville Carbonate) required only minimal support, for example, spot bolting in localized areas. However, it is recognized that even the best geotechnical investigation can only identify those features which are intersected by the borings, and that subsurface conditions between borings may vary considerably. Therefore, it was decided to provide four tunnel support designs in the contract to accommodate the likely variations in ground conditions which might be encountered during construction. As the tunnel was excavated, the actual ground conditions encountered were evaluated by a geotechnical engineer familiar with the design requirements, and the most appropriate tunnel support design was selected for each region. This approach allows the contractor the greatest flexibility in constructing the tunnel while affording the owner the lowest cost alternative based on the actual conditions encountered.

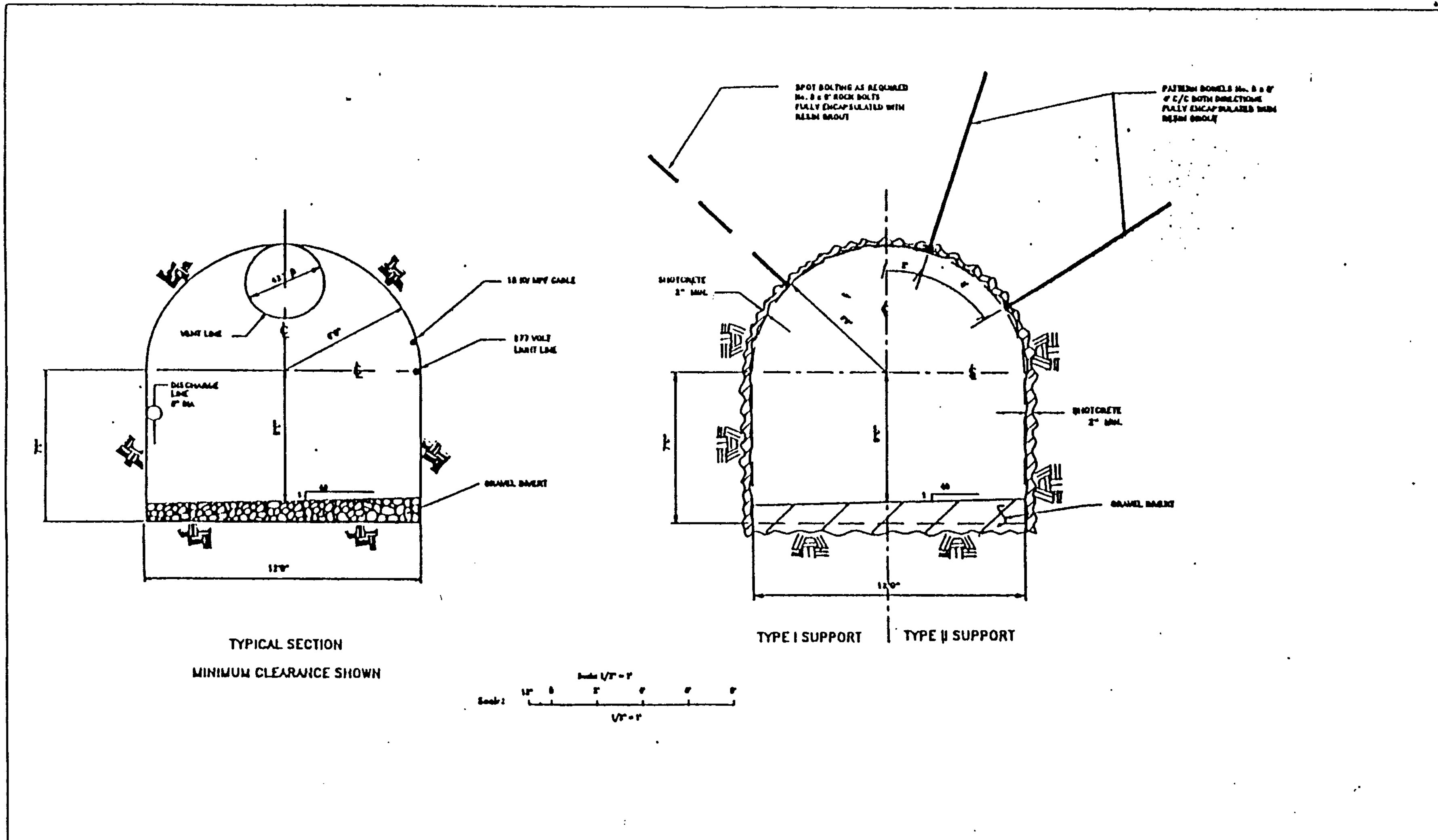

Figure 2-6. Tunnel Supports.

In determining the permanent ground support requirements, the rock mass characteristics developed during the geotechnical investigation were the primary factors considered in the design. However, additional factors such as extent of weathering, proximity to the surface, material durability, and dynamic loading from the future test events were also considered in determining the final support requirements. Based on the evaluation of rock mass characteristics and future use of the site, four types of tunnel support were selected for use in the contract. The support methods included: Type I Support, spot rock bolts (Number 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type II Support, pattern rock dowels (No. 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type III Support, pattern rock dowels (No. 8 by 8 foot long at 4 foot on center) with chain link fabric in the top 120° of crown; and Type IV Support, W6x25 steel sets at 4 foot center-to-center spacing. While the exact locations for each type of support were not determined at the time of bid, the contract provided an estimate of the quantity of each type for bidding purposes. These ground support methods are depicted in Figure 2-6,(Type I and II) and Figure 2-7 on the following page, (Type III and IV).

In addition to the main adit support designs detailed above, permanent ground support designs for the two transformer bays, two sump bays and the Calibration Adit intersection were specified in the contract. This consisted of pattern rock bolts (No. 8 by 10-foot long 4 foot on center)and a 2 inch thickness of non-reinforced shotcrete for the four bays, and a 4 inch thickness of wire reinforced shotcrete for the Calibration Adit intersection.

In the shale formations, the anticipated primary failure mode was the deterioration of the rock surface due to moisture loss, commonly referred to as air slaking, which causes the rock to ravel (disintegrate into pieces). To prevent this deterioration, a 2 inch minimum thickness of shotcrete was specified throughout the shale formations, and it was necessary to seal the shale with shotcrete within 24 hours of exposure to the atmosphere. In order to facilitate the tunnel advance and reduce the cost of the project, the specifications allowed the shale to be covered with a air-excluding sealant within the first 24 hours of exposure to temporarily protect the rock surface from deterioration or air slaking. The permanent shotcrete lining was then applied some distance behind the advancing face, effectively removing it from the daily mining cycle and allowing the contractor to utilize a separate and more efficient operation.

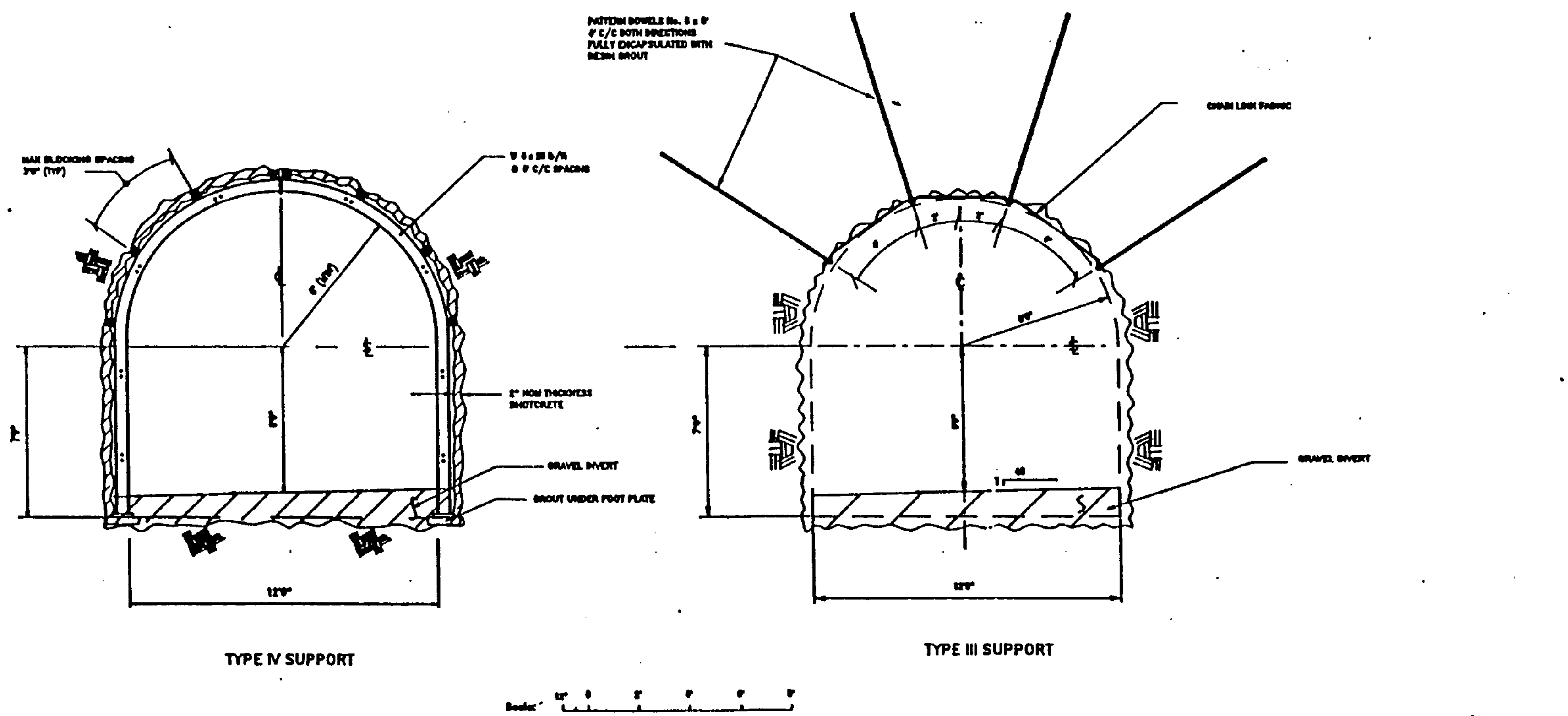

Figure 2-7. Tunnel Supports.

2.2.6. Electrical and Mechanical Systems.

The contract included a permanent electrical power distribution and lighting system for both the surface and underground work areas. This system included the 1,000 kVA main substation located above the adit portal. The system also included transformers and distribution systems for the contractor's yard area and the tunnel services. The tunnel system consisted of three substations each comprised of a transformer and power distribution panels. One substation was located together with the main substation on surface, and the other two substations were installed in enlargements in the main adit at Station 15+00 and Station 29+73.

The permanent mechanical systems included a tunnel ventilation system, and a dewatering collection and discharge system. The tunnel ventilation system included two 42-inch diameter, 75 horsepower axial vane fans and approximately 3,100 linear feet of 42 inch diameter steel vent line. The dewatering system included: four 2,800 gallon sumps, two located at the portal, and two located in the tunnel at Stations 14+56 and 30+17; six submersible pumps, and approximately 3,100 linear feet of 6 inch diameter steel discharge line.

2.3 CHANGES DURING CONSTRUCTION.

While there were a number of minor changes during the course of the contract, there were only four substantial changes which affected the final configuration of the project. Of these four significant changes, two were contractor initiated, one was Owner initiated, and one was due to differing site conditions.

2.3.1 Contractor Initiated Changes.

The first contractor initiated change dealt with the 6 inch discharge line from the adit portal to the Salt River. The contract required that a 6 inch spiral weld steel pipe with Victaulic couplings be installed on the ground surface from the portal to a discharge point in the Salt River, which the contractor was required to maintain during the life of the contract. The contractor proposed changing this to a buried 6 inch PVC pipe in place of the above ground steel pipe. While the installation cost to bury the line was higher than the above ground installation cost, there were savings in material and line maintenance expenditures realized for the duration of the contract, and for future contracts as well. This made the revision virtually a no-cost change for the Government and it was accepted on that basis.

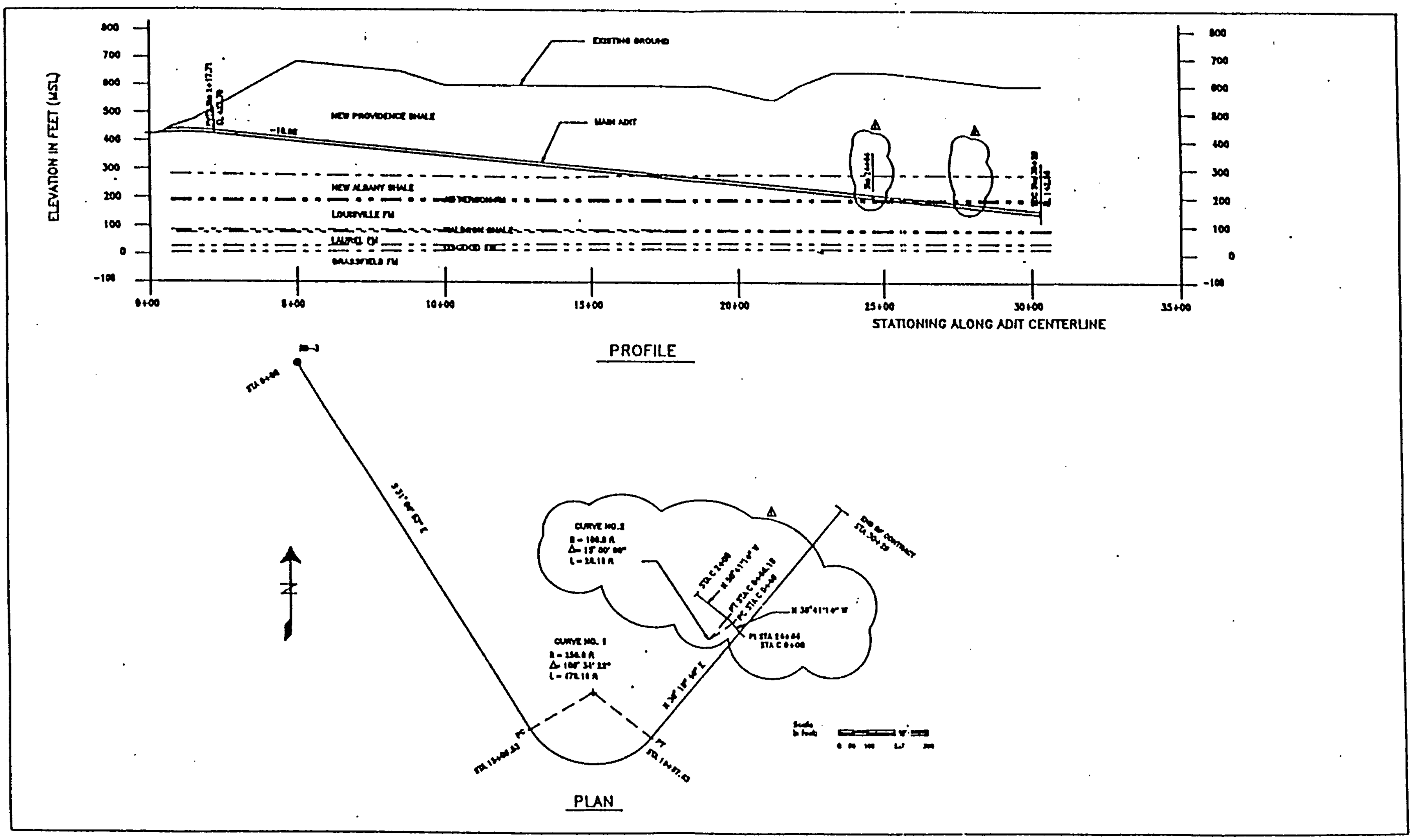

Figure 2-8. Revised Cal Adit Plan & Profile.

The second contractor initiated change involved substituting a 6 inch thick wire reinforced concrete invert in the shale formations for the 1 foot thick gravel invert specified. The contractor proposed this revision as a no-cost change, noting that the increased cost for the concrete invert would be offset by a savings in increased mining production and reduced maintenance of the tunnel invert. The change to a concrete invert in the shale formations was accepted by the Government.

2.3.2 Owner Initiated Change.

As plans for the overall test configuration for the UTP test bed were developed further, the Government found it necessary to relocate the Calibration Adit to accommodate the overall test objectives for the UTP. The Government initiated a design change which relocated the Calibration Adit from Station 28+00 with a bearing of S80°41'14"E to Station 24+64 with a bearing of N35°41'14"W. The change also eliminated the 100 feet of 8 foot by 8 foot drift and replaced it with a additional 100 feet of 12 foot by 13 foot drift and 10 feet of 10 foot diameter shaft. Figure 2-8 shows the alignment changes and Figure 2-9 on the next page depicts the Calibration Adit and Charge Shaft details.

This change was negotiated with the contractor, but it was never implemented due to the more sweeping changes in the scope of the project necessitated by the differing site condition at Station 18+54.

2.3.3 Differing Site Condition.

On June 25, 1993, when the tunnel heading was at Station 18+54, detectable levels of methane gas were encountered. The contractor immediately ceased mining operations, withdrew the roadheader from the face, and instituted a gas monitoring program to determine the extent of the gas inflow. Over the course of the next several days, the gas monitoring program indicated that while the flow of explosive gas was sporadic, varying from zero to greater than 20 percent of the Lower Explosive Limit (LEL) of methane, it was continuing, and exceeded the OSHA limits. This necessitated a change in classification of the tunnel from "non-gassy" to "gassy". The revision in tunnel classification required that the mining equipment, ventilation equipment, and electrical equipment be changed to comply with the more stringent requirements for gassy tunnels. Over the next several months, various alternate plans to continue the project were evaluated on the basis of UTP requirements, safety compliance, constructibility, and cost and schedule impacts.

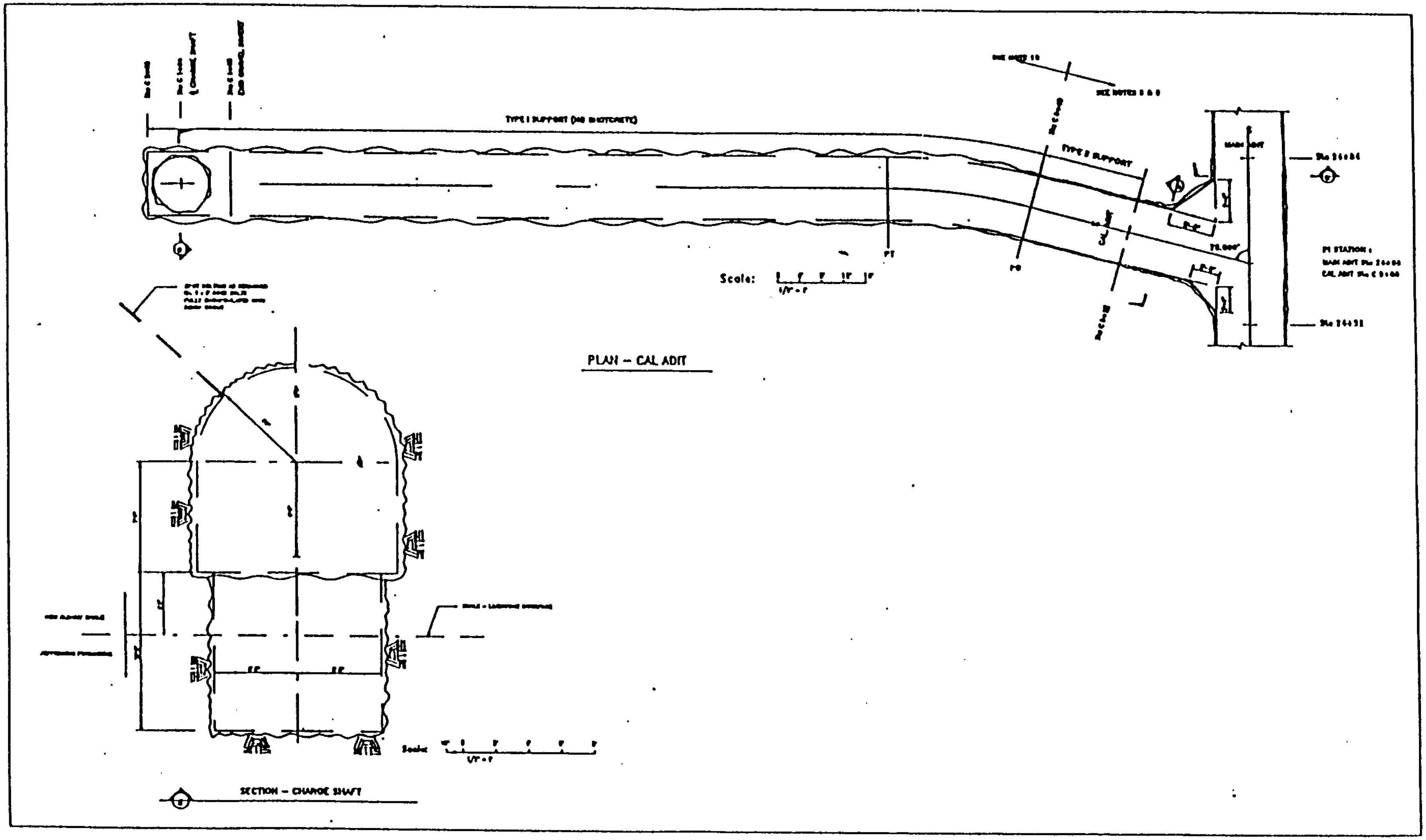

Figure 2-9. Revised Cal Adit.

A ventilation expert from the Bureau of Mines, and additional safety personnel from the DNA Field Command, Las Vegas, were brought in to assist in the development of the alternate plans for the completion of the test adit construction contract. Based on an evaluation of the alternate plans available, and an extensive review of the overall UTP requirements, DNA directed that the adit construction be terminated at Station 18+54. DNA also directed that the gas producing portion of the tunnel had to be sealed with a containment plug and pressure grouting, similar to that utilized at the Nevada Test Site (NTS), and that a 12 foot wide by 13 foot high test adit be constructed parallel to and below the existing main adit. As a result of this determination, the following changes were implemented:

1. The existing ventilation system was upgraded by replacing the non-explosion-proof fan with an explosion-proof fan.

2. A continuous gas monitoring system with remote sensors was installed and interlocked to the tunnel lighting and mine power feed systems.

3. The gas inflow was isolated from the work area with concrete slab and vent pipes connected to a main vent line. Figure 2-10 on the next page shows this arrangement.

4. A containment plug was installed from Station 17+70 to Station 18+00 utilizing the NTS grout mix and a pressure grout containment plug (see Figure 2-10).

5. 524 feet of a 12 foot wide by 13 foot high test adit was constructed starting at the main adit Station 16+00 and progressed on a 0.5 percent slope up and back toward the portal on a parallel heading, 100 feet north of the main adit. Figure 2-11, which follows, provides an as-built plan and profile for this revision.

6. The main adit from Station 18+54 to Station 30+29 was deleted.

7. The electrical substation at Station 29+73 was deleted and the permanent electrical distribution in the tunnel was revised.

8. The dewatering sump at Station 30+17 was eliminated and the 6-inch tunnel discharge line was terminated at the dewatering sump at Station 15+00.

9. The Revised Calibration Adit at Station 24+54 and charge shaft was deleted.

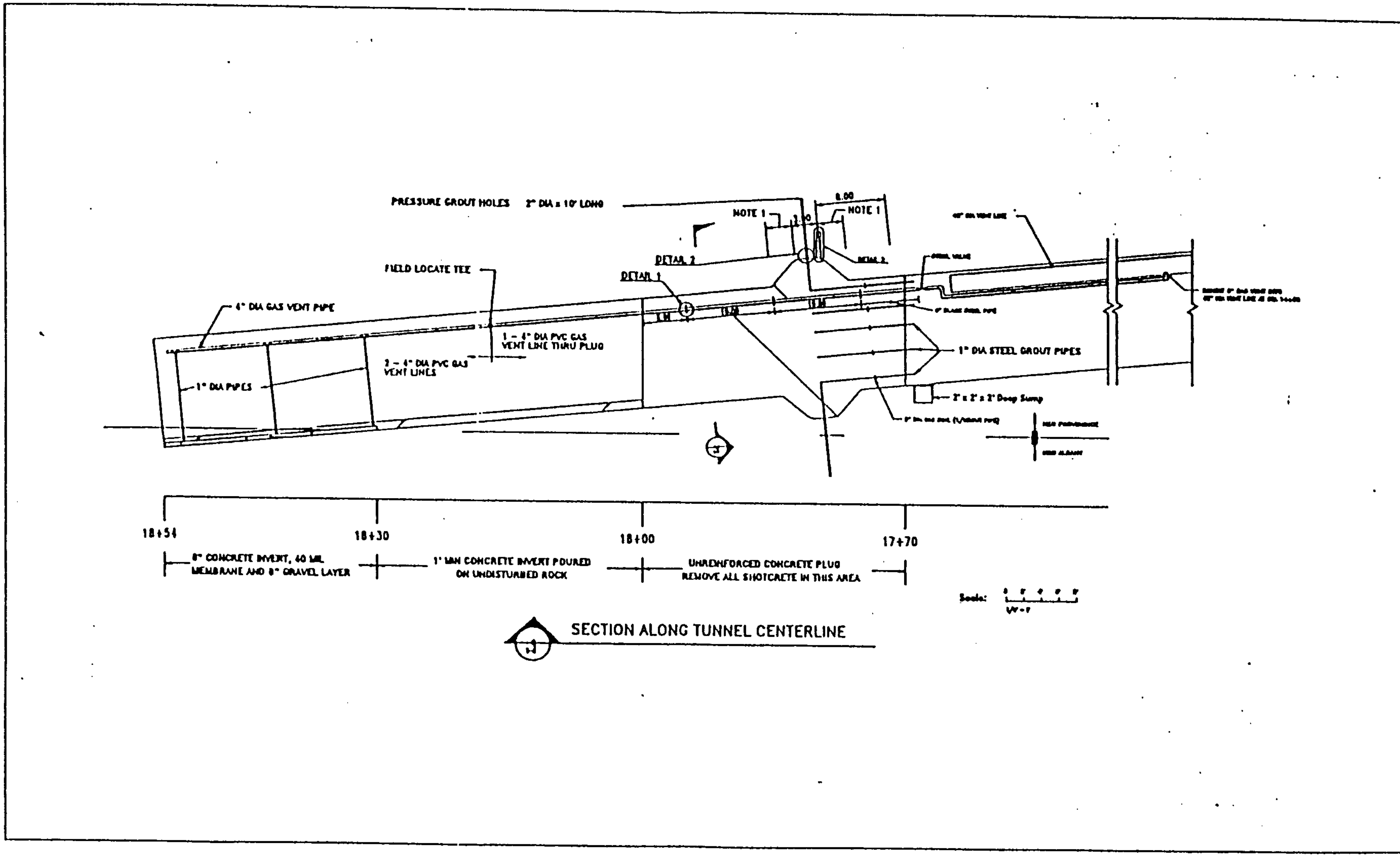

Figure 2-10. Gas Containment Plug.

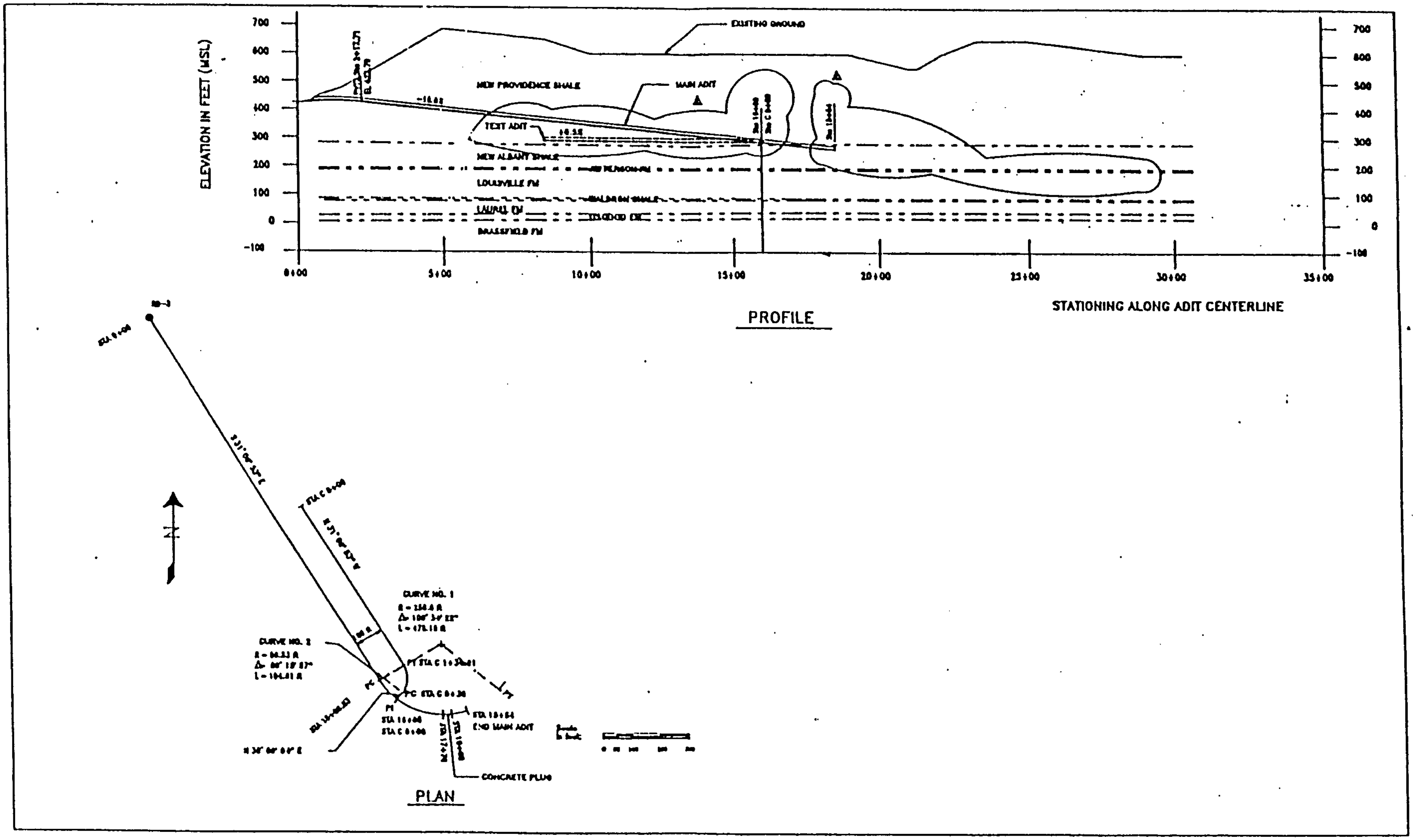

Figure 2-11. As-Built Plan & Profile.

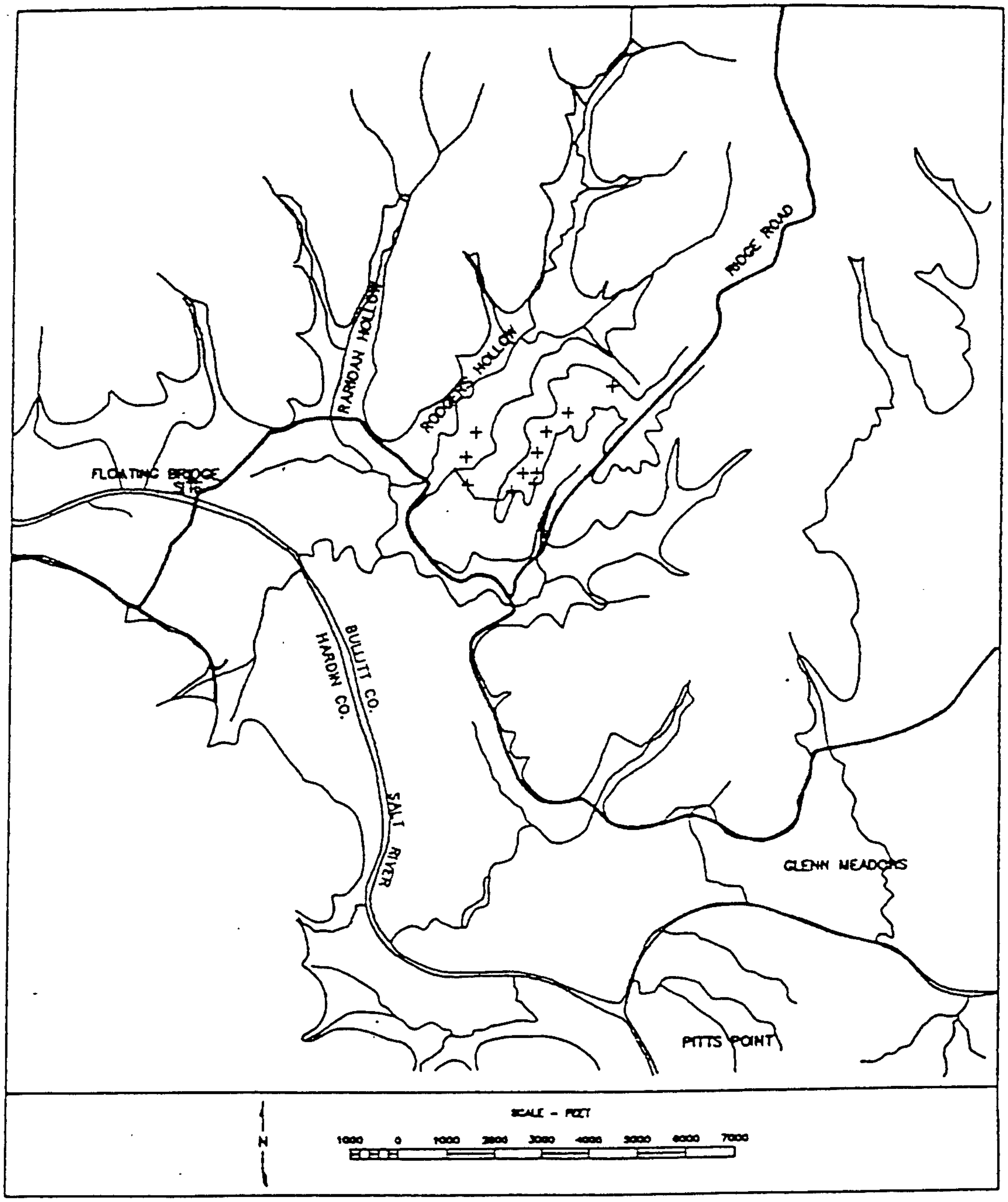

Figure 3-1. Rodgers Hollow Area.

SECTION 3

GEOLOGY

3.1 GENERAL SITE AREA .

The UTP project area lies beneath a ridgeline and immediately east of a small tributary valley to the Salt River on the northern end of Ft. Knox. A map is provided in Figure 3-1, as well as earlier in Figure 1-1. The portal for the adit was excavated on the lower hillslope of the ridgeline, just above the slope break to the valley, which is called Rodgers Hollow. The Rodgers Hollow area is characterized by a relatively flat valley floor surrounded by hills on three sides. The area is drained by a small unnamed creek that branches into two forks in the northern portion of the hollow. This creek flows into the Salt River approximately 0.6 miles southwest of the entrance of Rodgers Hollow.

The overburden material in Rodgers Hollow consists of quaternary alluvium and lacustrine deposits; generally light-tan to dark-brown silts and clays with varying amounts of sand, gravel, and rock fragments. Zones of gray to olive-gray silty clays are commonly encountered in an intermix with the brownish material. The overburden slopes toward the drainageway in the hollow and nominally parallels the ground surface contours. In many areas of Rodgers Hollow, the water table is 2 to 6 feet below the ground surface.

The bedrock at the portal elevation is shale that is a part of the Mississippian-age Borden formation. The portal was constructed at the boundary between the upper shale member of the Borden Formation, the Nancy Member, and the underlying New Providence Shale Member (see Figure 3-2 on the next page). At this site, the Nancy and New Providence Members are essentially indistinguishable, although the silt content of the Nancy Shale is known to be slightly higher than that of the finer grained, underlying New Providence Shale. The general hillslope, above the slope break to the valley, has a minimal soil profile and a weathered zone approximately 20 to 30 feet thick. Because the New Providence and Nancy Members of the Borden Formation are so impervious to water, the depth of weathering usually does not exceed 30 feet below the ground surface.

The Nancy Member Shale base lies at the portal elevation and is approximately 150 feet thick, so that under the main portion of the ridgeline, the Nancy Shale overlies the adit for a considerable thickness. The New Providence Member Shale continues 180 feet beneath the portal. Another 80 feet of shale thickness, the New Albany Shale, exists below the New Providence, making the total

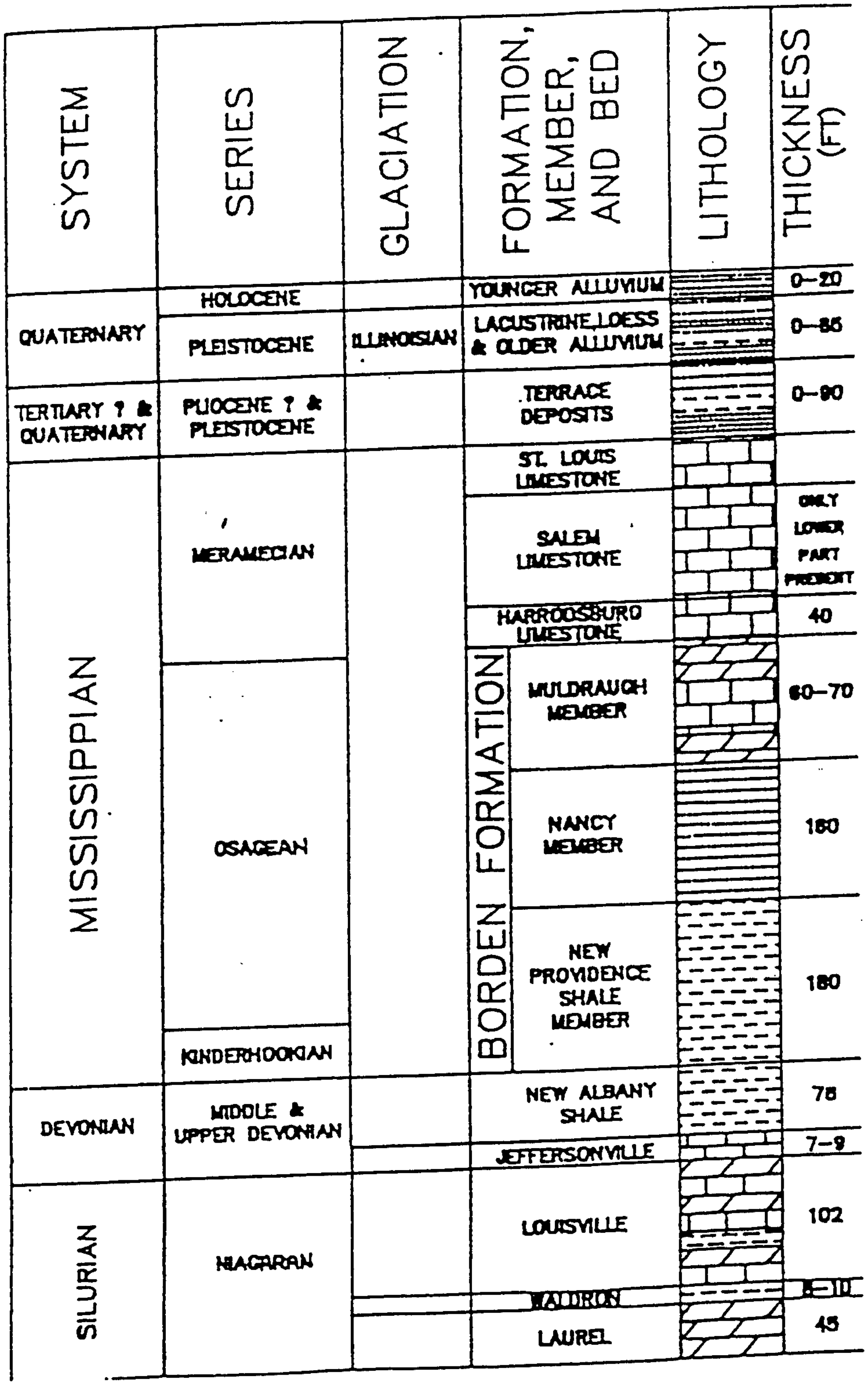

Figure 3-2. Strategraphic Column of Ft. Knox UTP Area of North Central Kentucky.

aggregate thickness of shale above and below the portal elevation greater than 300 feet. Beneath the New Albany are the initial test target carbonates of the Louisville Formation.

The uppermost hillslopes, just below the ridge line, are also predominantly shale, yet they actually classified as shaley siltstone with minor beds of limestones, dolometic siltstones, shales, and sandstones. The materials are of the Upper Borden Formation (Muldraugh Member). The ridge-capping materials consist of the Harrodsburg and the overlying Salem Formations. All the hillslope and ridgeline materials are of Mississippian age. The stratigraphic relationship and thicknesses of the rocks of this area of Ft. Knox are shown in the stratigraphic column on Figure 3-2 opposite.

The valleys bordering the test site ridge have been formed by erosional processes of the tributary streams; however, the valleys in the vicinity of the test site have also been affected by a major glacier advance during the Illinoisan Ice Age which occurred approximately 200,000 years ago. Glaciers advanced to within 50 miles of the site area. The advance, along with the climate effects associated with the glacial period, caused substantial erosion and alteration to the existing drainage of the area, including the rerouting of the ancestral Ohio River from a more northerly position to the one now currently occupied (Reference 1) as shown in Figure 3-3 on the next page.

The ice advance caused the pooling of water in many very large areas, including a huge temporary lake in the vicinity of Louisville, which encompassed Rodgers Hollow and the nearby valleys. This led to the deposition of some very low-strength lacustrine (lake bed) silty clay units in the valleys. The weak lacustrine deposits associated with the valleys were not a factor in the adit design and construction because they exist at elevations below the portal, and are present only within the valley boundaries.

3.2 ADIT GEOLOGY .

A geologic profile along the adit centerline is shown in Figure 3-4 which follows. The adit portal materials consist of the basal Nancy Member Shales and upper New Providence Shales of the Borden Formation. As the adit penetrates deeper, the New Providence Shale, while appearing lithologically quite consistent, has a gradual decrease in the fine-grained, granular quartz content with increasing depth. The contact with the underlying New Albany Shale is obvious, as it is where the dark gray shales of the New Providence give way abruptly to the dark brown shales of the New Albany. The New Albany is a more competent shale than the New Providence, although it is less dense because of the high

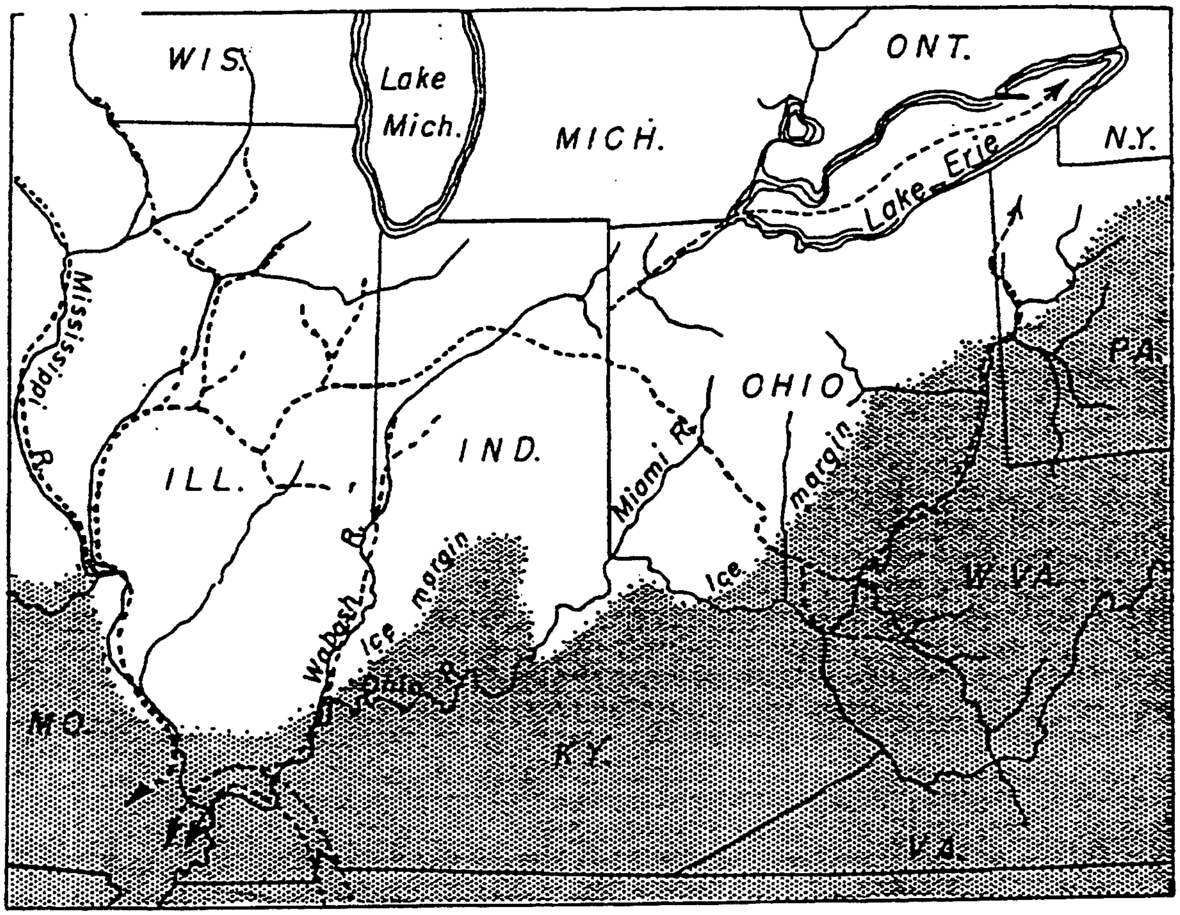

Figure 3-3. Maximum Advance of Glaciers In
Ft. Knox Revion.

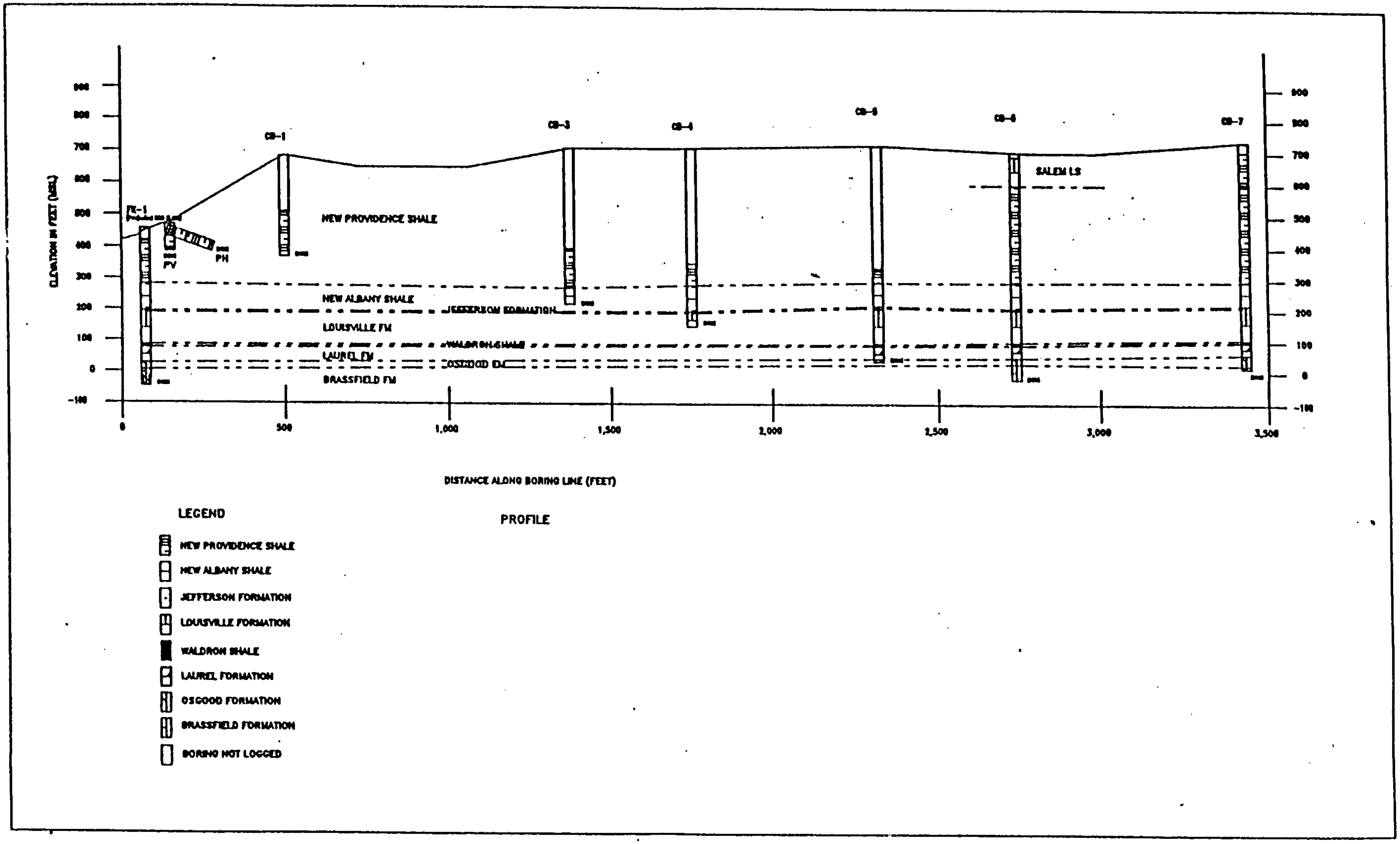

Figure 3-4. Geologic Profile Along Adit Centerline.

percentage of kerogen (organic material) it contains.

Below the New Albany there is an equally recognizable transition to the important carbonate (limestones and dolomites) section of the test horizon. The uppermost carbonate formation is the Jeffersonville limestone which varies in thickness through the test area from 6 to 9 feet. Beneath the Jeffersonville is the 100 feet thick Louisville Carbonate Formation. The Louisville is difficult to distinguish from the overlying Jeffersonville, unless it is tested by applying hydrochloric acid. The Jeffersonville is mostly limestone (calcite ($CaCO_3$)) while the Louisville is predominately dolomite (Ca, $MgCO_3$). However, there are zones within the Louisville which are rich in calcite and can be classified as limestone, hence, the term Louisville Carbonate was chosen.

Since the adit was never intended to penetrate below the Louisville Formation, the deeper formations (Laurel, Osgood, and Brassfield), which were penetrated by the exploratory borings, are not described herein.

3.3 FIELD EXPLORATION PROGRAM .

The geotechnical characterization of the UTP project site consisted of field explorations and testing. The purpose of the explorations was to provide the factual data to characterize the site for testing purposes, and to identify the geotechnical conditions expected during excavation of the portal and adit, including the geologic formations, rock type and condition, and the anticipated ground water conditions which had to be addressed. To accomplish this task, four geologic exploration techniques were used: core drilling; hydrologic testing and water sampling; geophysical logging; and formation gas detection.

The exploration activity was chronologically subdivided into four different phases. These were: 1) site-selection, 2) adit lay-out, 3) groundwater monitoring and testing, and 4) formation gas detection. Ft. Knox was only one of a number of sites considered during Phase 1, site selection, and the last of this work was accomplished during calendar year 1990. Phases 2, 3 and 4 were accomplished only for the Rodgers Hollow site, and were conducted concurrently during the calendar year 1991. Additional exploration activities classified under phases 2 and 3 were conducted during the construction of the test adit in the calendar years 1992 and 1993.

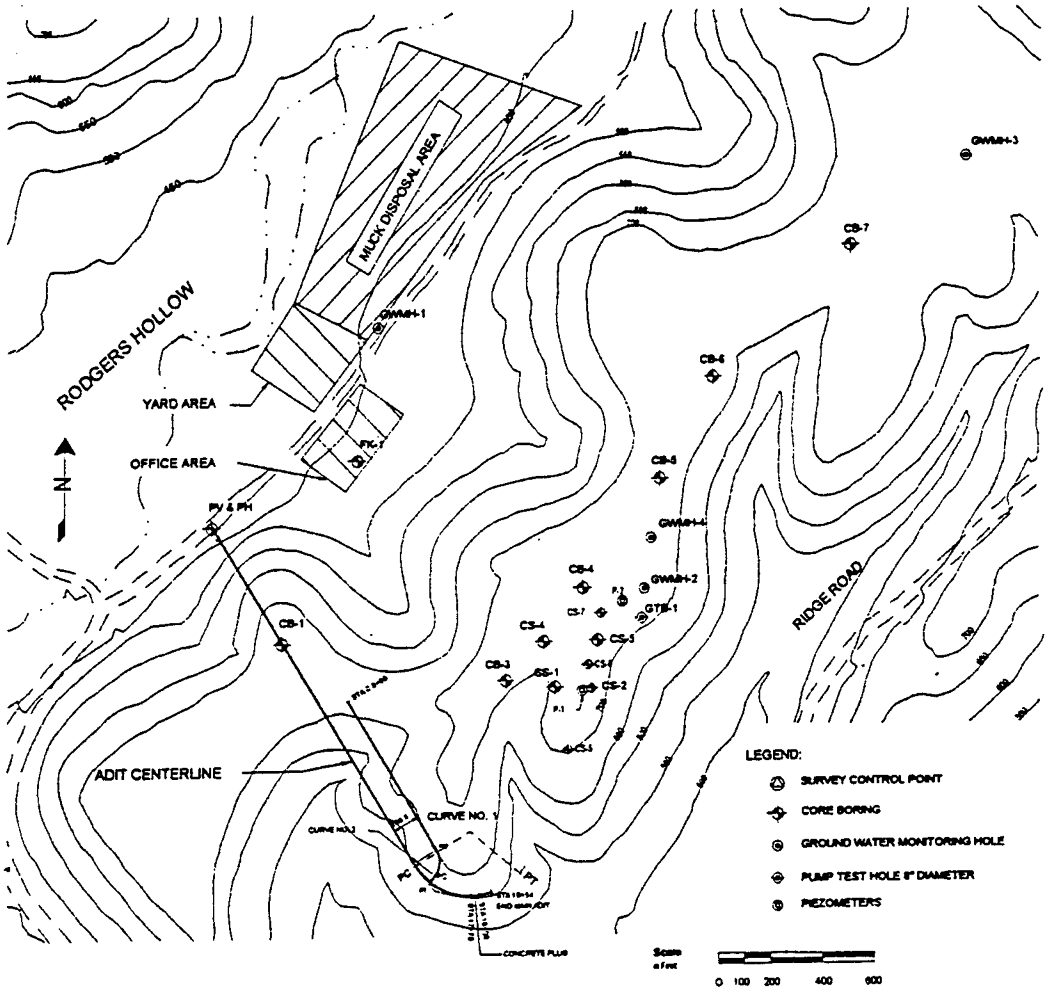

Figure 3-5. New Site Plan With All Borings Shown.

3.3.1 Core Drilling.

A total of 15 NQ and NX core borings were drilled and logged as part of the preconstruction exploratory program developed for the UTP. During the site selection (Phase 1) of this project, two borings, FK-1 and FK-2 were cored with NQ wireline equipment, each to a depth of 500 feet. This work was performed under contract for WES using a Failing 500 drill rig. Site-specific explorations (Phase 2) to lay out the adit and define the anticipated tunneling conditions included borings CB-1, CB-3, CB-4, CB-5, CB-6, and CB-7 (boring CB-2 was not drilled). Explorations conducted to define the conditions at the portal location included one vertical and one angle boring, designated PV and PH respectively. All of the Phase 2 drilling was performed by U.S. Army Corps of Engineers drill crews. Five additional borings, GWMH-1, GWMH-2, GWMH-3, GWMH-3A, and GWMH-4 were cored as part of Phase 3 groundwater monitoring program. All of these holes were drilled by the Corps of Engineers using HQ wireline equipment. Boring GWMH-3A was logged only by the geophysical surveys, and GWMH-4 was not logged at all.

During the Test Adit Construction phase of the UTP, an additional exploratory program was carried out in December 1992, and in May 1993, in which a total of 9 additional borings were drilled and logged. Piezometers were later installed in five of these borings (P-1, P-2, CS-5, CS-6, and CS-7) and in two of the previous borings (GWMH-2 and GWMH-4). The boring locations are shown on Figure 3-5 on the opposite page and the logs of the borings are presented in Appendix A.

3.3.2 Geologic Discontinuities.

Based on data obtained from the preconstruction exploratory borings and other available geologic data available, it was concluded that no faults or shears would be encountered. It was also concluded that bedding plane joints, which are horizontal to moderately inclined, would comprise the majority of joints encountered.

Discontinuities in the New Providence Shale are typically planar, tight to moderately tight, horizontally oriented (0^0 to 10^0) with smooth to slightly rough surfaces and with a few occurrences of soft clay fillings. The discontinuities are mostly unweathered. The New Albany Shale, on the other hand, has steeper discontinuities (0^0 to 40^0), with occasional calcite and pyrite fillings. The joints are planar, slightly rough to rough-surfaced, moderately tight to tight, and unweathered. The Louisville Carbonate Formation typically has a higher frequency of discontinuities than both the New Providence and New Albany Shales. Discontinuities here are steeper (0^0 to 50^0), and are open. Calcite fillings are frequent along the joints. Weathering of discontinuities in the Louisville Carbonate Formation is more

evident.

Geologic mapping of main and test adits confirmed the exploratory data obtained for the New Providence Shale. In accordance with the exploratory data, no shears or faults were encountered and only five open and bentonite-filled joints were encountered. All of these were encountered in the first 141 feet of main adit, close to portal (Station 0+94 to Station 2+34). Every one of these discontinuities were transverse and vertically oriented (252^0 to 263^0 Azimuth strike and 75^0 to 85^0 NW dip direction).

There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62. Their measured Azimuth strikes ranged from 305^0 to 335^0, except for the bedding plane at Station 17+65 which had a 285^0 Azimuth strike. Dip angles for these planes were 6.5^0 to 9^0 NW direction except for the plane at Station 17+65 which had a SW dip direction.

Since all of the explorations, other than portal boring PH, were drilled vertically, exploratory data would be biased against high-angle fractures, and the exploratory borings data for the New Albany Shale and the Louisville Carbonate Formation may not be representative of what might be encountered in the adit when tunneling into these strata.

3.3.3 Hydraulic Testing and Water Sampling.

The UTP site-selection criteria required that the final experimental test bed be located in a water-saturated, carbonate rock. The hydrologic properties of the Louisville Formation are important characteristics, not only for test bed predictions, but also for anticipating ground water conditions during construction. To that end, a program to establish and define the hydrologic nature of the site was developed and consisted of:

1. Constant head tests using downhole packer injection to establish rates of flow and hydraulic conductivity by depth interval.

2. Water sampling to determine water quality.

3. A long-term (25-hour) pump test to determine the ability to draw down the primary aquifer at the site (Louisville Carbonate Formation).

The injection (pump in) tests were conducted in seven of the NQ boreholes to determine the volume of water required to maintain a constant head.

Table 3-1. Summary of Aquifer Water Quality .

ANALYSIS	RESULTS
Conductivity	27,000 micro-omhs
ph	7.01
Total Alkalinity	456
Chloride	11,535 mg/l
Calcium	588 mg/l
Magnesium	336 mg/l
Sodium	5,620 mg/l
Hardness ($CaCO_3$)	2,820 mg/l
Total Dissolved Solids	16,500 mg/l

Determining the quality of the groundwater present in the Louisville Formation was an important consideration in the planning of the UTP Test Adit Project. An uncontaminated water sample was obtained from boring CB-6 and chemically tested. The results of the laboratory test are reported in Appendix B.3 of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) and are provided in Table 3-1. Due to the high chloride content of the groundwater, it was necessary to make special provisions in the contract to pipe the tunnel discharge water to the Salt River and to specify minimum dilution factors for its discharge into the river.

The long term pump test was performed using a large diameter boring, denoted as borehole GTB-1. An 8-1/2 inch diameter hole was drilled with an air hammer to a depth of 102 feet, and a 6 inch diameter PVC pipe was set in place and sealed with Bentonite. The remainder of the hole was then drilled with a 6 inch diameter air hammer button bit to a total depth of 640 feet. Detailed results of this test were reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) Tables 3-2 and 3-3 on the following page summarize the results from the active and passive pumping phases of the pump test performed at boring GTB-1.

Based on the data obtained through the hydraulic testing program conducted at the site, it was established that the porosity in the carbonate material, known in many situations to be laterally variable, exists only on a minor scale in the immediate vicinity of the Louisville Carbonate Formation of interest. Furthermore, the Louisville Formation water reservoir could be considered isotropic in properties and in extent. The two distinct porosity zones of the Louisville Carbonate Formation, the upper and the lower porosity zone, appear to be both laterally continuous (at least in the area of the program borings), as suggested by their presence in each well of the pump test program. Also, only partial water level recovery was achieved in a 24 hour period after pumping. This suggests that the extent of the aquifer is limited.

Using the characterized coefficient of transmissibility in the vicinity of borings GTB-1 and GWMH-2 as 750 to 1120 gpd/ft (100 to 150 ft^3/day/foot), as reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) and using 74 feet as the nominal aquifer thickness, the equivalent hydraulic conductivity would be 1.35 to 2.03 ft/day. Assuming a steady-state drainage for both the borehole and the adit under a constant water head of 270 ft, the tunnel was estimated to produce about 510 to 766 Ft^3 of water per day per foot of length in the aquifer (see Appendix B.2). This translates to approximately 2.6 to 4.0 gpd per foot of adit. Since the adit was designed to have a 10 percent downward grade, the 74 feet of aquifer translates to approximately 740 feet of aquifer zone penetration. The resulting total flow within the Louisville

Table 3-2. Coefficients of transmissibility and storage, Active Pumping Phase GTB-1.

WELL TEST	RANGE FROM GTB-1 (FT)	COEF TRANS (T) GPD/FT	COEF STORAGE (S)
GWMH-2	121	676	3.60
GWMH-4	320	1650	1.34
CB-5	540	663	1.75
CB-6	960	539	1.90
FK-1	1250	499	1.53
GWMH-1	1520	580	0.92
CB-7	1590	434	0.61
GWMH-3A	2090	868	0.48

Table 3-3. Coefficients of transmissibility and storage, Passive Recovery Phase GTB-1.

WELL/TEST	COEF TRANS (T), GPD/FT
GWMH-2	729
GWMH-4	1600
CB-5	1422
CB-6	1307
FK-1	937
GWMH-1	904
CB-7	1114

aquifer was calculated to be 1,925 to 2,960 gallons per day.

3.3.4 Geophysical Surveys.

Geophysical wireline logging was conducted in each of the core borings drilled at the site in the preconstruction exploration phase, except for the portal area borings (PV and PH) and the air drilled boring (GTB-1). Various types of geophysical logs were performed during this program. All logs were run in the open hole within several months of the completion of the drilling of each hole. The types of log runs, the principle of measurement, the recorded parameters of each log type, and the results of the logging are summarized in Section V of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2).

3.3.5 Formation Gas Detection.

In an attempt to detect the possible presence of formation hydrocarbon and/or hydrogen sulfide (H_2S) gases, a "mud logging" unit was employed during the air drilling of boring GTB-1 in July, 1991, to monitor the returning air stream in order to determine the presence and concentration of either or both of the gases.

The hydrocarbon gas detection involved the use of two instruments, a total hydrocarbon gas detector, and a gas chromatograph unit. The total hydrocarbon gas detector that was utilized on the UTP logging is commonly referred to as a thermal conductivity detector (TCD). This unit provides a continuous measurement of the presence and level of total combustible gases either within the flow stream, as in the case of air drilling, or emanating out of solution from the recirculating mud stream. The gas chromatograph, uses discrete samples, separating the mixture into its component gases, and then samples each component. In this way the device can determine the type, such as methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane and/or isobutane (C_4H_{10}), and pentane (C_5H_{12}), and concentration of each component gas within. Methane (CH_4) gas was detected in borehole GTB-1. The total hydrocarbon gas concentration was measured and recorded, as well as an independent methane concentration level. The results are presented in Figure 3-6 on the following page.

Figure 3-6 also shows the data recorded from the hydrocarbon gas detectors adjacent to the lithologic log and stratigraphic column. There was no gas was detected through the entire Borden Shale section of the hole. The first detection of gas corresponds with the drill bit penetration into the top of the organically rich New Albany Shale, and the sustained high readings matched almost perfectly with the interval within the New Albany Shale which has the highest natural gamma ray activity on the geophysical log. In

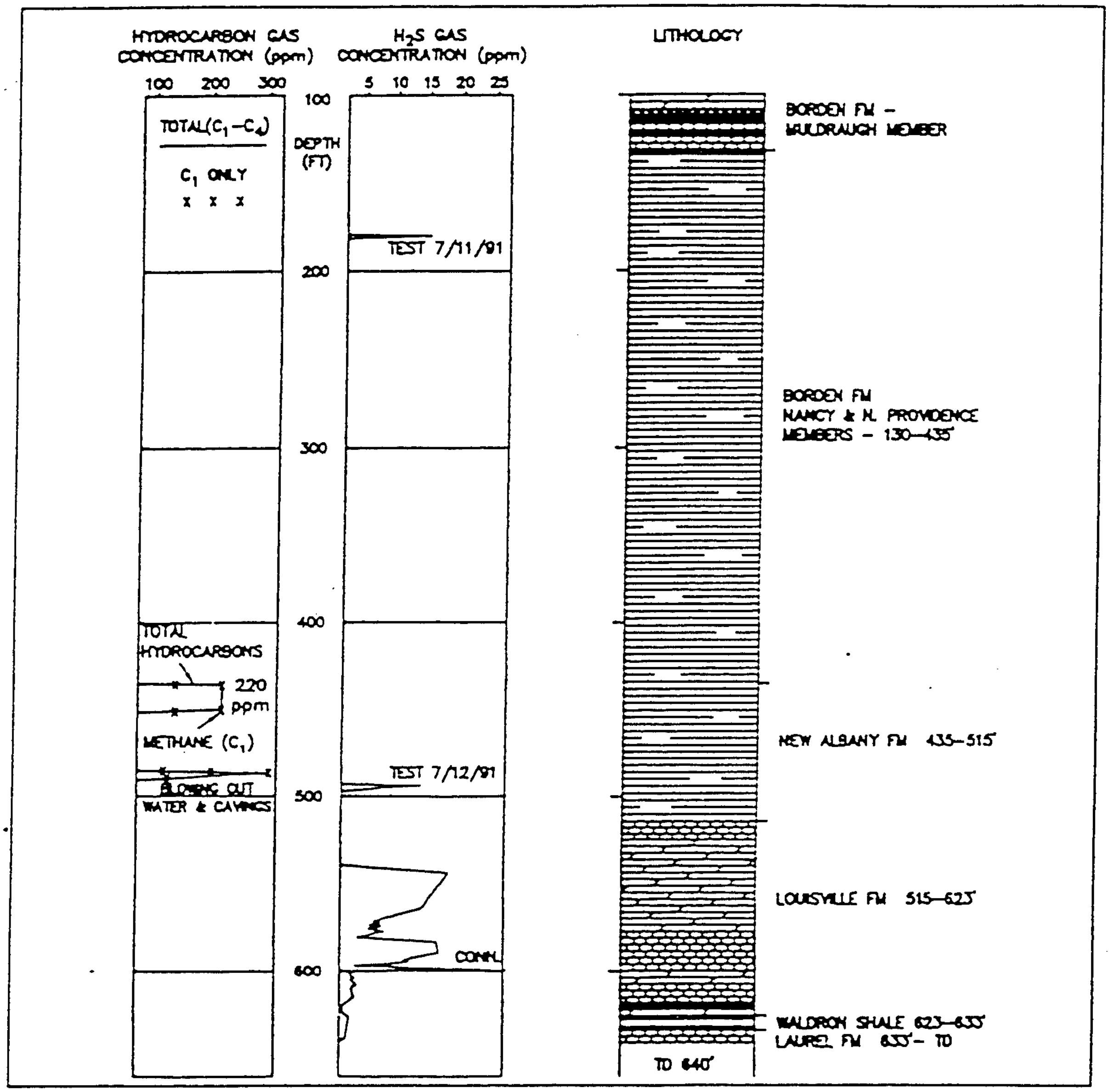

Figure 3-6. Formation Gas Log for Boring GTB-1.

previous studies, this interval has been shown to possess the highest organic material content in the form of kerogen as well (Reference 7.2 in GEOTECH REPORT). Samples of this material have been triaxially tested in the laboratory and have been observed to release hydrocarbon gas after testing. Based on the formation gas detection operation, it was determined that small quantities of methane (CH_4) gas may be encountered as the adit is driven through the upper portion of the New Albany Shale.

The presence of hydrogen sulfide (H_2S) gas in the UTP adit was another concern since it could represent a serious hazard to personnel. In an attempt to detect the presence and measure levels of hydrogen sulfide gas, two types of sensors, one active (Metal Oxide Detector) and one passive (Lead Acetate Paper), were employed to monitor the exit air stream while drilling borehole GTB-1. The data obtained from that monitoring program is displayed adjacent to the lithologic log and stratigraphic column in Figure 3-6 It can be clearly seen that the occurrance of H_2S corresponds to the upper porosity zone in the Louisville Formation.

The formation gas monitoring project resulted in the detection of both hydrocarbon and hydrogen sulfide gases. Each was identified in distinct and isolated intervals.

During construction of main adit, methane (CH_4) gas was encountered in the top 2 to 3 feet of the New Albany Shale, as gas perculated from two 0.1-inch wide, calcite filled, open vertical joints in the New Albany Shale in the adit invert at approximate station 18+50. Analysis of the air/gas samples taken revealed that the emitted gas was 98 percent methane (CH_4) with the remainder being primarily carbon dioxide (CO_2) and ethane (C_2H_6). Concentrations for samples taken at adit face were 24 ppm of CH_4 on the left side, 463 and 155 ppm CH_4 at center (2 samples), and 64 ppm CH_4 at right side. Hydrogen sulfide gas was not encountered, since no tunneling in the Louisville Carbonate Formation was performed.

3.4 UNDERGROUND GEOLOGIC MAPPING .

The Full Periphery Method (developed by the U.S. Corps of Engineers) was adopted for mapping the underground geology encountered in the excavation of the adit. The mapping indicated that the New Providence Shale was massive with few discontinuities. Five vertically oriented, bentonite filled joints were encountered in the first 50 feet of the main adit excavation. Another set of tight, mostly vertical joints was encountered between Station 2+29 and Station 2+35. As noted in Section 3.3.2, There were four bedding planes encountered in the main adit at Station 4+55, Station 16÷07, Station 16+55, and Station 17+62.

Cobble-size siderite intrusions occurred frequently throughtout the New Providence Shale and one 8 inch thick siderite dike was encountered in the main adit from Station 15+64 to Station 16+54 and continued on in the test adit to Station C 3+10. The New Providence Shale started displaying organic laminar deposition patterns at about Station 15+00, where shale started to have horizontal bands of olive-green to grayish green coloration that became increasingly dominating and distinct as excavation advanced deeper into the New Providence Shale towards interface with the dark brown colored New Albany Shale (encountered at Station 15+34). Detailed geologic maps are presented in Appendix C.

3.5 SITE HYDROGEOLOGY .

The test site selection criteria required a saturated carbonate section at the test depth, therefore, a discussion of the hydrology of area becomes necessary to complete the description of the geology of site area. Two hydrologic regimes are discussed, the soil water, and the water within the rock units. Please refer to Section 3.3.3, Hydraulic Testing and Water Sampling, for details of hydrological testing performed for the UTP.

3.5.1 Soil Water .

The valleys contain a shallow perched water table. Boreholes drilled at various locations within the Rodgers Hollow area, below the grade change controlled by the weathering of the rock slopes, all indicated the presence of the shallow water table. The recorded piezometric levels showed a remarkable seasonal dependence. For example, the water table at a site a small distance up the valley from the portal area had been observed at a depth of 2 to 4 feet below the surface in February to April, and as deep as 9 or 10 feet in August through early November. This perched aquifer exists only at elevations within the valley proper and below the portal elevation, so that it should not be a factor in either portal construction or within the adit.

3.5.2 Rock Hydrology .

The hydrology of the rock materials affects the design parameters of the adit construction. For the purposes of this discussion, the rock hydrology will be divided into three zones: the Shale Zone; the Louisville Carbonate Zone; and the Deep Zone, i.e. the Waldron Formation into the Laurel Dolomite (Laurel Zone).

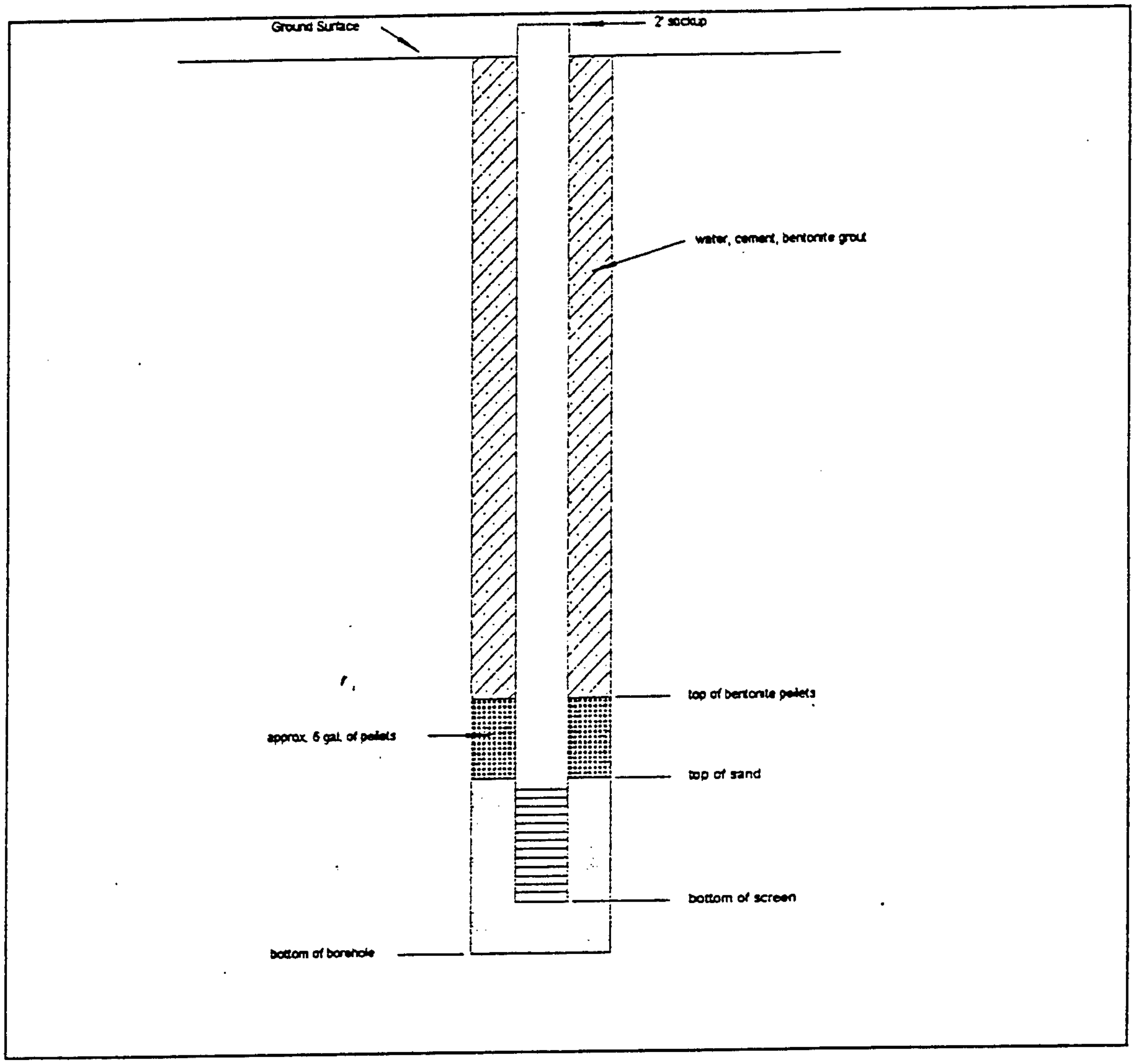

Figure 3-7. Typical Profile of Installed Piezometers.

3.5.2.1 <u>Shale Hydrology</u>. All of the shale units encountered above the Louisville Carbonate give evidence of 100 percent water saturation. However, no noticeable water flow has been encountered while drilling within the Borden or New Albany Shales. Thus, from a hydrologic engineering standpoint, only minor water seepage would be expected while tunneling through the shales.

3.5.2.2 <u>Louisville Carbonate Hydrology</u>. Two zones of water flow within the Louisville Carbonate have been detected and hydrologically tested. The upper zone is variable in thickness, but the base of the zone lies 35 to 40 feet below the base of the New Albany Shale. This zone is identified as the major water producing zone of the site. The lower water-bearing zone of the Louisville lies approximately 20 feet above the underlying Waldron Shale. This zone is also variable in thickness and permeability, but can generally be classified as less water-productive than the upper zone.

3.5.2.3 <u>Deep (Laurel) Hydrology</u>. The only recognized potential water zone below the Louisville Carbonate at the site is a zone within the Laurel Dolomite. There is relatively little known about this zone since it lies below the depth of interest for testing. Where this formation was penetrated by boreholes, it was found that it is located about 15 feet below the base of the Waldron Shale at approximately the 650 feet depth (as encountered in boreholes CB-5 and CB-6). The fluid conductivity/temperature geophysical logs do not demonstrate significant fluid entry from this zone, although the reservoir properties suggest it could be a water-bearing strata of minor to intermediate importance.

3.6 HYDROLOGIC MONITORING

A total of seven piezometers were installed in 1993 during construction of the test adit by the WES crew at boreholes GWMH-4, GTB-1, P-1, P-2, CS-5, CS-6, and CS-7 to monitor the water table in the Louisville Formation Reservoir, prior to and during the penetration of the main adit. The data collected provided quick and accurate feedback on depletability, drainage profiles, and the pressure drop of the reservoir as the main adit was constructed, and also provided the means necessary to determine if remedial steps were needed to be implimented so that the saturation of the Carbonate Formation could be maintained as required by the test parameters. A profile of a typical piezometer installation is shown in Figure 3-7 at left, and the locations of the piezometers are shown in Figure 3-8 on the next page.

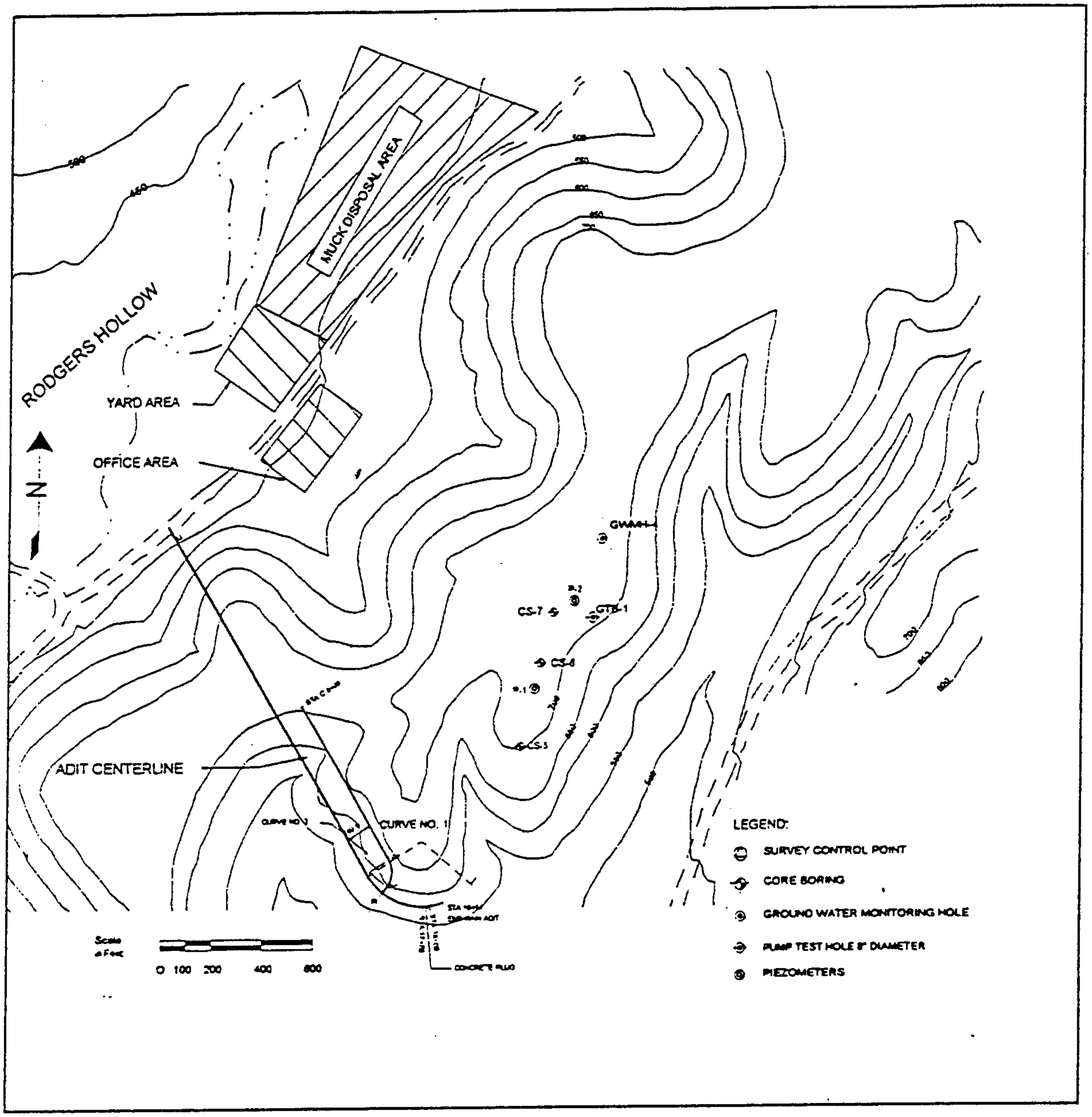

Figure 3-8. Location Map of Installed Piezometers.

SECTION 4

CONSTRUCTION METHODS

4.1 GENERAL.

A Request for Proposals (RFP), Solicitation No. DACA27-92-R-003 Underground Technology Program, Test Adit Construction, was issued in May, 1992 by the U.S. Army Engineer District, Louisville. A total of ten proposals were received in June, 1992 and, after evaluation of the proposals, a contract was awarded in July, 1992 to W.L. Hailey & Co., Inc. of Nashville, Tennessee. The contract provided for a one year construction period for the completion of the test adit and all appurtenant features of the permanent work.

The contractor began mobilization at the site in early August, 1992 and completed the initial site work, office set up, and site preparation, on October 20, 1992. Portal construction commenced on October 13, 1992, with the clearing of the portal area and the backfill of the structure was completed on December 23, 1992. Tunnel excavation commenced on December 28, 1992, and progressed to Station 18+54 on June 25, 1993, at which time methane gas was encountered in the heading and the tunnel excavation was halted. Work in the tunnel resumed on November 8, 1993, with the installation of vent line hangers in the main adit. The gas collection system was installed between November 15 to November 18, 1993 and the containment plug was constructed between November 22, 1993 and February 28, 1994. The test adit was excavated concurrently with the containment plug construction between November 22, 1993, and February 11, 1994. The balance of the contract work, electrical, mechanical, invert placement, shotcrete lining and final tunnel clean up was performed from March 1, 1994 through May 7, 1994.

4.2 PORTAL CONSTRUCTION.

The portal construction involved an open cut excavation of both overburden and shale. The overburden material was excavated using a dozer, loader, and dump trucks. The side slopes of the overburden excavation were laid back, thereby eliminating the need for the support of excavation structure. The shale cut was excavated utilizing drill and blast methods to break the rock, and a loader and dump trucks to excavate the shot rock. The side slopes of the rock cut were excavated with a slight outward batter to eliminate the need for any rock support.

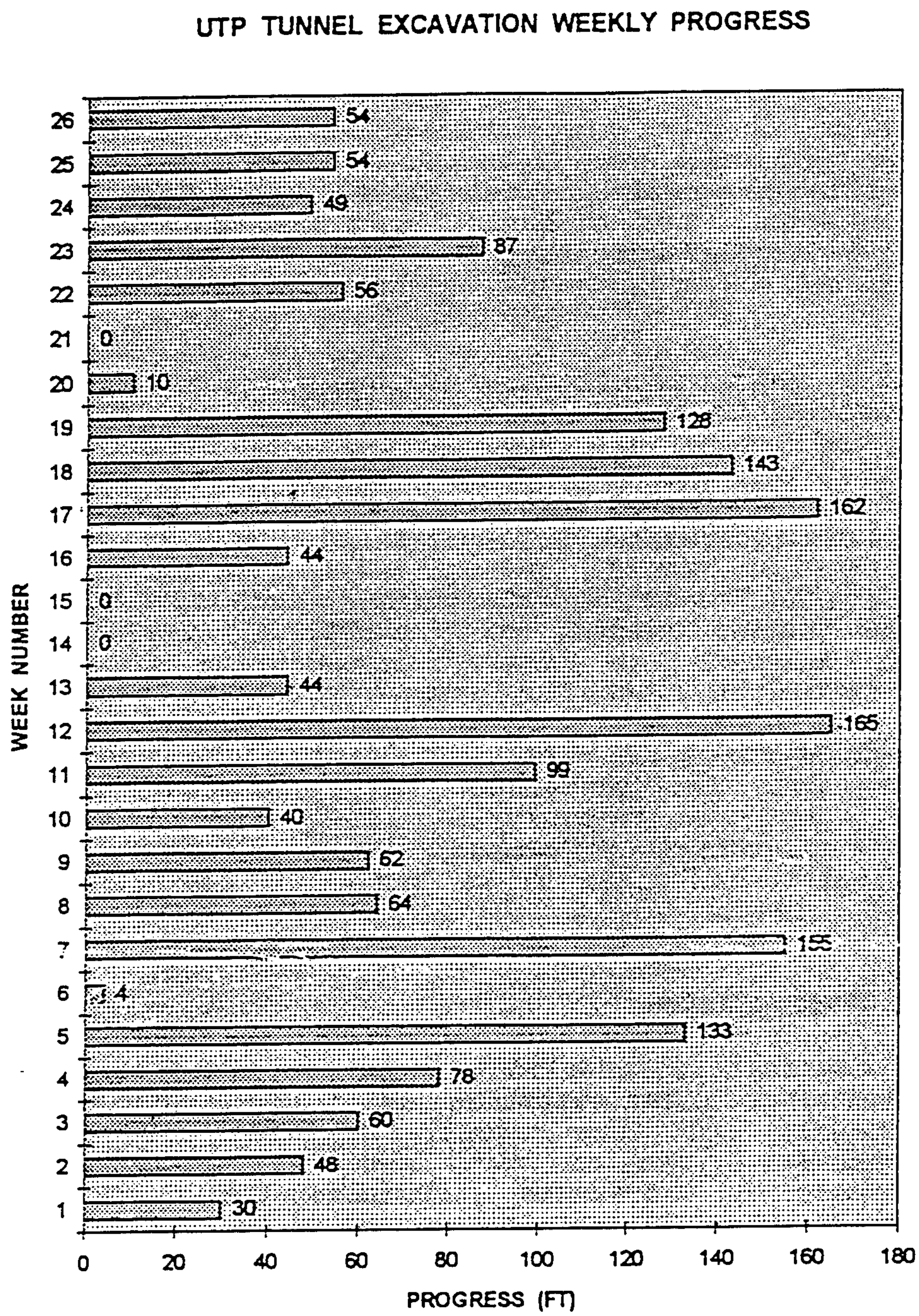

Figure 4-1. Tunnel Progress Summary, (Chart 1 of 2).

After completion of the excavation, the steel ribs (W6x25s) were installed and the concrete invert poured. The 6 inch thick wire reinforced shotcrete was then placed between the ribs and the structure was backfilled. The reinforced concrete U-Wall structure was built by normal cast-in-place methods with wood forms.

4.3 ADIT EXCAVATION.

Tunneling operations commenced on December 28, 1992, at Station 0+94 using a Voest-Alpine Roadheader to mine the shale, and a pair of 5 cubic yard Eimco low profile mine trucks were used for muck removal. The contractor selected this type of equipment for excavating the the shales because it provided a more continuous mining operation. This method significantly reduced overexcavation, and eliminated many of the safety hazards that are inherent in a drill and blast operation.

Throughout the tunnel excavation, the contractor mined the required cross section with minimal variance, and maintained line and grade well within tolerances. The roadheader and heading crews limited overexcavation and minimized the disturbance to the rock beyond design line. However, the actual advance rates for the roadheader operation never approached the anticipated rates. The estimated production rates for the roadheader excavation were an average of 15 linear feet of advance per 8 hour shift after an initial startup period. The contractor was prepared to mine two shifts per day and use a third shift to install ground support and tunnel utilities, as well as maintain the mining equipment. In this way, he had planned to mine and support an average of 30 linear feet per day, or 150 linear feet of tunnel per five day work week.

In the period from December 28, 1992 to June 25, 1993, the contractor worked a total of 141 days and mined 1,760 linear feet of adit. The overall average for this period was 12.5 feet per day and 67.7 feet per week. There were only six weeks in which production levels exceeded 100 feet per week, and the best weekly production was 165 feet. At left, Figure 4-1, provides the weekly advance rates for the first twenty-six weeks. The rates for the remainder of the project may be found on the following page. Of the total 141 day project duration, the contractor was able to mine on 89 days, and lost a total of 52 days for the following reasons: 13 days were spent on ground support installation; 12 days due to equipment breakdowns; 12 days for concrete operations on the invert; 8 days for ventilation system installation; and 7 days due to inclement weather.

On June 25, 1993, methane gas was detected in the tunnel at Station 18+54. The quantity and duration of the gas entering the

UTP TUNNEL EXCAVATION WEEKLY PROGRESS

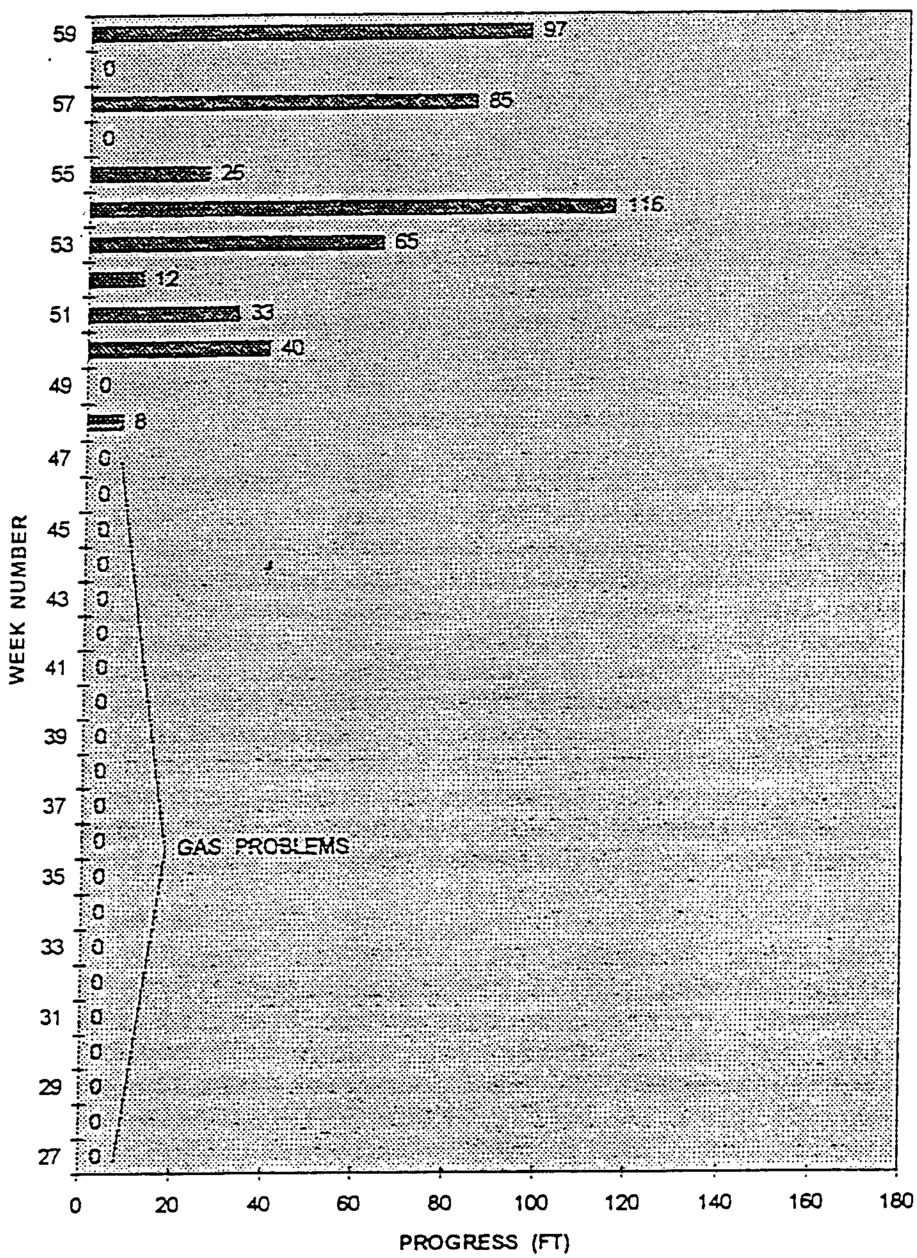

Figure 4-1. Tunnel Progress Summary (Chart 2 of 2), (Continued).

tunnel was sufficient to require that the tunnel be re-classified as a "gassy" tunnel. Mining operations were discontinued for a period of 23 weeks while alternate plans were developed to deal with the gassy conditions. As noted in Section 2.3.3, Differing Site Condition, the decision was made to terminate the main adit at Station 18+54, seal the tunnel with a gas containment plug from Station 17+70 to Station 18+00, and to realign the test adit to remain totally within the New Providence Shale.

The test adit was excavated from Station C 0+06 to C 5+24 during the period of November 22, 1993 to February 11, 1994 and utilized the same equipment and methods as the main adit. Unlike the main adit, the test adit was excavated essentially on a single shift basis, four days per week. The average production rate for the 518 linear feet of tunnel was 13 feet per day on a single shift basis, which is more than twice the advance rate achieved in the main adit. Figure 4-1, Chart 2 of 2, at left shows the weekly advance rates in the test adit.

4.4 GROUND SUPPORT

As discussed in Section 2.2.5, Ground Support, there were four types of ground support provided for the contract, with the determination of which type to employ, made in the field as the excavation progressed. As anticipated, the New Providence Shale was massive and competent, and required very little direct ground support. A total of six steel sets were installed at the beginning of the adit from Station 0+94 to Station 1+18. A total of twenty-two rock bolts and twelve rock dowels were installed in the main adit from Station 1+22 to Station 2+36. The permanent support for the sump bay (Station 14+54) and transformer bay (Station 15+16) consisted of a total of 101 rock bolts, and the support of the adit intersection (Station 16+00) consisted of seventy-two rock dowels.

The only area of the main adit which required a substantial number of rock dowels was from Station 16+56 to Station 18+46. In this reach of the tunnel, the New Providence Shale had a tendency to spall and ravel at crown of tunnel when the heading face advanced two tunnel diameters further. As the excavation progressed, the New Providence Shale became more organic and displayed planar, thin, lamination layers at crown, beginning at Station 15+02. At approximately Station 16+60, spalling of rock from crown started occurring more frequently, and the size of the spalled rock fragments increased to approximately 1 foot wide by 2 foot long and 2 to 3 inches thick. Even though the shale formation was still massive and structurally self-supporting, the spalling posed a safety hazard to the workmen in the heading, and the contractor was directed to install rock dowels from Station 16+56 to the

Table 4-1. Summary of UTP-Permanent Support Utilized.

ADIT STATION	TYPE OF SUPPORT INSTALLED
0+94 to 1+18	Steel ribs (6 ea)
1+22 to 1+33	Spot rock dowels (16 ea)
1+45 to 1+51	Spot rock bolts (12 ea)
2+32 to 2+36	Spot rock bolts (6 ea)
5+68 to 5+80	Spot rock bolts
14+35 to 15+38 (Sump Bay)	Patterned rock bolts (47 ea)
14+93 to 15+38 (Transformer Bay)	Patterned rock bolts (57 ea)
15+80 to 16+20 and C 0+12 to C 0+21 (Intersection)	Patterned rock bolts (72 ea)
16+56 to 18+46	Patterned rock bolts (212 ea) (with wire mesh from 17+58 to 18+44)

face, located at Station 17+35, before any further advance of the heading. The contractor was also directed to have rock dowels installed within 15 feet of the face at all times. Therefore, patterned rock dowels were installed from Station 16+56 to Station 18+46. Table 4-1 lists the different support systems used and their location in test adit.

All rock bolts and rock dowels were fully resin-encapsulated Number 8 threaded rebar, Grade 60 steel. The typical bolt/dowel length was 8 feet except for a number of 10 foot long bolts which were used at the sump and transformer bays and at the adit intersection.

While the adits required only minimal direct ground support for safety and stability, the New Providence Shale did require a shotcrete lining to permanently seal the excavated surface to prevent long-term deterioration of the shale due to air slaking. A nominal 2-inch thickness of shotcrete was applied throughout the entire length of both the main and test adits, and a 4 inch thickness was applied to the intersection area of the two adits.

4.5 GROUNDWATER OCCURRENCES

The only measurable water inflow encountered during tunneling was at the top of the New Albany Shale at Station 18+50. While the water inflow, estimated at less than 5 gpm, presented no problem to the excavation, the water was accompanied by methane gas. The impact of the methane gas is discussed in detail in Section 2.3.3, Differing Site Condition.

SECTION 5

TUNNEL INSTRUMENTATION

5.1 TAPE EXTENSOMETERS.

A total of six sets (four points each) of convergence points were provided in the bid schedule. These convergence points were to be installed as needed in the main and calibration adits to monitor movements of the tunnel lining in areas where the geological conditions warranted. Due to the massive nature of the New Providence Shale, only one set was required, and the instrument was installed in the main adit at Station 1+20 to monitor any movement close to the portal. A total of four readings were taken in the period from February 3, to February 8, 1993. The data obtained from these readings indicated that the movements were negligible and stabilized quickly.

5.2 SINGLE POINT BOREHOLE EXTENSOMETERS.

None of the six sets of Single Point Borehole Extensometers (SPBXs) that were provided for in the contract were required in the New Providence Shale, and none were installed.

SECTION 6

REFERENCES

1 Pitts Point Geologic Quadrangle Map, USGS Publication, 1976.

2 UNDERGROUND TECHNOLOGY PROGRAM, Geotechnical Design Summary Report, Volume 1.

3 UNDERGROUND TECHNOLOGY PROGRAM, Geotechnical Design Summary Report, Volume 2.

4 "*Petrophysical Analysis - US Army Corps of Engineers Hole FK-1, Bullitt County, Kentucky*", ResTech Inc., Houston Report, April 1990, Houston, Texas.

5 Underground Technology Program, Test Adit Construction, Solicitation No. DACA27-92-R-003, US Army Engineer District, Louisville, Kentucky,May, 1992.

6 Rock Engineering, J.A. Franklin and M.B. Dusseault, McGraw-Hill, New York, 1989.

Appendix A

Geologic Core Logs

Hole No. CS-1

DRILLING LOG

Field	Value
DIVISION	
INSTALLATION	
SHEET	1 OF 7 SHEETS
1. PROJECT	UTP
2. LOCATION (Coordinates or Station)	Ft. Knox, KY
3. DRILLING AGENCY	FHSM
4. HOLE NO. (As shown on drawing title and file number)	CS-1
5. NAME OF DRILLER	John Surber
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	140
9. TOTAL DEPTH OF HOLE	630.5
10. SIZE AND TYPE OF BIT	NQ wireline
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	B-61
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED: Dec. 10, 92 COMPLETED:
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Ghailan Alsayab

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Hole was pre drilled to 490.6′ depth & cased to a depth of 100′ with metal casing			
	490.6		Run ① 490.6 – 496.3			
			Run was cut short due to mechanical problems with core barrel. Dark brown, unweath. fine grained New Albany shale. Thinly laminated & finely grained, with pyrite lenses.			Recovery = 4.8′ Preserved core: 492.15 – 494.05
	496.3		Run ② 496.3 – 506.3			
			Same shale as in previous run. bottom of core 505.25′			Recovered 9.5′ Preserved: 496.4 – 497.4; 498.3 – 499.9; 499.9 – 501; 503.95 – 505. Water Loss = 100%, Drilling time = 45 min
	506.3					

A-3

PROJECT	HOLE NO.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE					Hole No. CS-1
PROJECT			INSTALLATION			SHEET 2 OF SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	506.3		RUN ③ 506.3 - 516			
			Dark brown shale changing @ 508 to light gray hard unweathered Lime stone. L.S. slightly porous & vuggy @ 509.5-506.15 with very thin soft gray shale interbeds (1-2 mm) plenty of pyrite horiz. interbeds (lenses) in the shale.			Recovery 9.35' Preserved core: 505.25 - 506.72 WL = 100% DT = 50 min
	516		RUN ④ 516 - 526			
			Light gray, mod. hard shaly L.S. non porous & unweathered with 1 inch interbed of shale (mod. soft, gray) at 516.			WL = 100% DT = 50 min Recovery = 10.1'
	526		RUN ⑤ 526 - 536			
			Light gray shaly L.S. mod. hard (scraped by knife easily), thinly laminated, unweathered			WL = 100% Recovery 10.25' DT = 30 min.

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF-620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. CS-1

PROJECT | INSTALLATION | SHEET 3 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	536		Run 6 536 – 546			
			536 – 536.45 light gray shaly L.S. changing to pure L.S. that is light gray with hues of darker gray color. mod. porous & Vuggy especially @ 538.7 – 539.2 & 542.8 – 543.8 with some deep vugs. @ 543.8 Core gets better in quality – non porous – and it has gray shale lenses.			DT = 25 min WL = 100 % Recovery 10.1'
	546		Run 7 546 – 556			
			Light gray L.S. w/ darker gray hues & horizontal soft gray shale seams. Changing @ 548 to tannish or pinkish gray L.S. (with quartz) slightly porous & sltly. weathered, coarse grained then changing again @ 554 back to light gray L.S. as at top. Some Vugs ... rock.			Recovery 10.05' WL = 100 %.

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF - 429 - 663 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. CS-1
PROJECT	INSTALLATION	SHEET 4 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Core breaks easily upon handling at gray shale seams.			
	556		RUN (8) 556 – 566			
			pinkish to tannish gray L.S., sltly. porous w/ dark gray hues and gray shale seams changing @ 564.5 to light gray non-porous L.S. The pinkish gray L.S. is coarser in grain than the lt. gray L.S. which is mod. coarse grained.			Recovery = 10′ WL = 50 % DT = 30 min.
	566		RUN (9) 566 – 574			
			Pinkish to tannish gray L.S. with darker gray hues & gray shale seams. Unweath. & hard.			Recov. 9′ Water Loss = 50 % D.T. = 1 hr
	574		RUN (10) 574 – 584			
			Same L.S. as in previous run, with soft gray shale lenses.			D.T. = 110 min WL = 50 % Recovery 10′

ENG FORM 1836-A (ER 1110-1-1801) GPO 1960 OF-620-603 | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-1
PROJECT	INSTALLATION		SHEET 5 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	584		Run (11) 584 – 594			
			Same L.S. as in previous run with vertical fractures and two broken rock zones @ 588.3 – 588.6 & 593 – 593.6 where drilling rod dropped. Top 2 feet non porous, fine grained getting porous & broken @ 587.5 – 589 w/ plenty of pyrite veins. Rest of core is mod. porous. .3′ thick quartz interbed @ 586.1 – 586.4			D.T. = 80 min. WL = 50 %. Recov. 9.3′ * plenty of pyrite at broken rock zones. * A vertical pyrite seam @ 587.7 – 590.0
	594		Run (12) 594 – 604			
			Light gray porous L.S. w/ plenty of quartz getting less porous @ 598 to bottom. Core has a weak fetted odor.			D.T. = 40 min WL = 100 %. Recov. 9.9′

ENG FORM 1836-A (ER 1110-1-1801) GPO 1980 OF – 620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. CS-1
PROJECT	INSTALLATION	SHEET 6 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	604		Run (13) 604 - 609			
			604 - 605 tannish gray L.S. changing to darker greenish gray L.S., fine grained, unweath. Plenty of soft gray horiz. lenses. Core is nonporous			WL = 100 % DT. = 40 min Recov. = 4.4
	609		Run (14) 609 - 615.5			
			609 - 612.5 light gray L.S., non porous, mod. fine grained changing to tannish gray L.S. w/ qtz. to bottom of core.			WL = 100 % DT = ? Recov. 7.2'
	615.5		Run (15) 615.5 - 625.5			
	619		615.5 - 617 L.S. as in previous run changing to shaly L.S. 617 - 619 (darker gray) then to greenish gray thinly laminated shale.			Recov. 10' WL = 100 % D.T. = 60 min Pres. core: 618 - 619.3 621.75 - 623.55 623.55 - 624.6

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF - 420 - 603 | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-1
PROJECT		INSTALLATION	SHEET 7 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	625.5		Run (16) 625.5 - 630.5			
	627		625.5 - 627 dark greenish gray shale changing to tannish gray L.S. to bottom			Recov. 5' WL = 100%. Pres. Core: 625.5 - 626.4
	630.5		Bott			

ENG FORM 1836-A (ER 1110-1-1801) GPO 1966 OF - 620-665 PROJECT HOLE NO

Hole No. CS-2

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 7 SHEETS
1. PROJECT: UTP		10. SIZE AND TYPE OF BIT: NQ wire line	
2. LOCATION (Coordinates or Station): Ft. Knox, KY		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): -	
3. DRILLING AGENCY: FMSM		12. MANUFACTURER'S DESIGNATION OF DRILL: B-61	
4. HOLE NO. (As shown on drawing title and file number): CS-2		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER: John Serber		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED Dec. 16 92	COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK: 142.4		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE: 642.4		19. SIGNATURE OF INSPECTOR: G. Alsayab	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Hole pre drilled to 500' depth & cased for 95'			
	500		Run (1) 500 - 505.4			
			Dark brown unweath. New Albany shale with some gray colored banding at top 2.5' of core. Thinly laminated, fine textured.			Water Loss = 0 D.T. = ? Pres. 500 - 500.8 501.3 - 502.1 503.85 - 504.85 Recov. 5.3'
	505.4		Run (2) 505.4 - 515.5			
			Same shale with more discontinuties - some vertical - Frequent pyrite lenses & one pyrite & L.S. lens @ 505.65 - 505.9			D.T. = 65 min. W.L. = ø Preserved: 507.9 - 508.55 508.55 - 509.3 509.85 - 510.6 510.6 - 511.35 514.4 - 515.15 Recov. 10.2'
	515.5					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE — Hole No. CS-2

PROJECT — INSTALLATION — SHEET 2 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	515.5		Run (3) 515.5 – 525.5			
			Same shale to 519.3 where core changes to vuggy, porous tannish gray L.S. At 521.5 rock change to finer grained, light gray to tannish gray non porous L.S.			Recov. 9.95′ D.T. = 35 min W.L. = ø Preserved core: 515.5 – 516.6 516.6 – 517.65 518.25 – 519.3
	519.3					
	525.5		Run (4) 525.5 – 535.8			
			Same L.S. as at bottom of previous run changing to darker gray shaly L.S. @ 527.6 which is unweathered, fine textured with some qtz.			Recov. 10.25 D.T. = 30 min. W.L. = ø Pres. core 528.2 – 529.1 529.1 – 529.4 532.6 – 534 534 – 535.8
	527.6					
	535.8		Run (5) 535.8 – 545.8			
			Shaly L.S. as above changing @ 544.3 to porous dark gray L.S.			D.T. = 30 min W.L. = ø Recov. = 10′

ENG FORM 1836–A (ER 1110-1-1801) GPO 1966 OF-420-001 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE				Hole No. CS-2
PROJECT		INSTALLATION			SHEET 3 OF SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			L.S. gets less shaly @ 537.3 to bottom.			Pres. core:
	544.3					
	545.8		Run (6) 545.8 – 556			
			L.S. porous, tannish gray, vuggy, slightly weathered & odorous Rock improves in quality at bottom 1' (i.e. 555–556) Some gray shale veins.			Recov. 10.2 D.T. = 25 min W.L. = ø
	556		Run (7) 556 – ~~566~~ 566			
			Same light gray non porous L.S. as at bottom of last run changing @ 599.5 to tannish gray, porous silty. weath. L.S. w/ vuggs. Some gray shale veins. Smells like H_2S.			Recov. 10' D.T. = ? W.L. = ø

ENG FORM 1836–A (ER 1110-1-1801) GPO 1960 OF – 620–603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE — Hole No. CS-2

PROJECT — INSTALLATION — SHEET 4 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Run (8) 566 – 576			
	566		Tannish gray L.S. slly. weathered & frequently jointed at 568.5 – 574.6 w/ some porosity. Some gray shale veins. odorous.			Recov. 10′ D.T. = 40 min. W.L. = ∅
			Run (9) 576 – 586.2			
	576		SW tannish gray L.S. as above. Non-porous, coarse grained with shale lenses & veins.			W.L. = ∅ D.T. = ? Recov. 10.2
	586.2					

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1968 OF-430-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE					Hole No. CS-2
PROJECT		INSTALLATION				SHEET 5 OF SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Run (10) 586.2 – 596.4			
	586.2		Same L.S. as in previous run			Recov. 10.2′ D.T. = 50 min. W.L. = ∅
			Run (11) 596.4 – 606.3			
	596.4		Same L.S. as above changing @ 602 to pinkish gray, porous & vuggy L.S. with fetted odor.			Recov. 9.9′ D.T. = 50 min W.L. = ∅
			Run (12) 606.3 – 616.3			
	606.3		Porous pinkish gray vuggy L.S. with frequent discontinuities changing @ 613.8 to darker ' h			Recov. 9.8′

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1969 OF - 420-003 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-2		
PROJECT		INSTALLATION		SHEET 6 OF SHEETS	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			gray L.S. with plenty of qtz mixed with the L.S. Non porous to slty. porous			
	616.3		Run (13) 616.3 - 626.3			
			Sam as above to 624.8 where it gets tannish-gray and coarser grained			Recov. 9.7' D.T. = 30 min W.L. = ø
	626.3		Run (14) 626.3 - 636.3			
	628.8		Tannish gray L.S. as above changing @ 628.8 to shaly L.S. down to 630.6 & grading again to dark gray limy shale down to 632.			D.T. = 30 min. W.L. = ø Pres. core: 632.7 - 634 634.2 - 635.55
	632		632 - 636.2 gray waldron shale unweath, mod. soft			Recov. 9.9'

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-2
PROJECT	INSTALLATION		SHEET 7 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	636.3		Run (15) 636.3 - 642.4			
			Top to 638' pure waldron shale, gray unweath.			Pres. Core: 636.6 - 637.6 637.6 - 639.1
	638		638 - 639.8 limy shale.			Recov. 6.2'
	639.8		639.8 - BOH tannish gray L.S. slightly porous.			
	642.4		624.4 BOH			

ENG FORM 1836-A (ER 1110-1-1801) GPO 1968 OF-625-683 PROJECT HOLE NO.

Hole No. CS-3

DRILLING LOG

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 7 SHEETS

1. PROJECT	UTP
2. LOCATION (Coordinates or Station)	Ft. Knox, KY
3. DRILLING AGENCY	FMSM
4. HOLE NO. (As shown on drawing title and file number)	CS-3
5. NAME OF DRILLER	John Serber
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	139.6
9. TOTAL DEPTH OF HOLE	639.45
10. SIZE AND TYPE OF BIT	NQ wire line
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	B-61
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED: Dec. 29 COMPLETED: Jan. 4, 93
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	Ghailan Alsayab

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Hole pre drilled to 499.8' & cased down to 95'			
	499.8		Run (1) 499.8 – 505			
			Dark brown shale (New Albany) unweath, frequently jointed, with some pyrite lenses			D.T. = W.L. = ø Recov. 5' Pres. Core: 502.53 – 503.15 503.15 – 503.75
	505		Run (2) 505 – 514			
			shale – same as above.			Recov. 8.8' D.T. = 40 min W.L. = ø Pres core: 505.35 – 506.07 507.7 – 508.55 508.55 – 509.4 509.4 – 510.45 511.2 – 511.95 511.45 – 513.55
	514		Run (3) 514 – 524			
			514 – 517.5 New Albany shale as above changing at 517.5 to tannish gray L.S., porous.			Recov. 10.2' D.T. = 90 min. W.L. = ø

A-19

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. CS-3
PROJECT	INSTALLATION	SHEET 2 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			At 520 L.S. gets non porous & shaly. L.S. has plenty of mixed qtz.			Pres. core: 515.5 - 517.05
	524		Run (4) 524 - 534.3			
			524-525.8 light gray nonporous L.S. 525.8-526.2 L.S. gets mixed w/ gray shale getting shaly L.S. @ 526.2 - bottom. Fine grained, nonporous, and unweathered.			Recov. 10.3 D.T. = 90 min W.L. = ∅ Pres. core: 526.2 - 527.3 528.65 - 529.82 531 - 532.5 532.5 - 533.7
	534.3		Run (5) 534.3 - 544.3			
			shaly L.S., same as above with blended quartz. L.S. gets less shaly & coarser grained @ 541.5 to bottom. 544 - 544.3 cement-gray L.S.			Recov. 10' D.T. = ? W.L. = ∅ Pres. core: 534.3 - 535.7 536.8 - 537.68 538.2 - 539.45 540.3 - 541.65 541.65 - 543.2

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF - 620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. CS-3
PROJECT	INSTALLATION —	SHEET 3 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Run (6) 544.3 - 554.6			
	544.3		Light gray L.S. with plenty of qtz, porous, unweath., with fetted odor. Frequently jointed			Recov. 10.3' D.T. = 60 min W.L. = ø
			Run (7) 554.6 - 564.4			
	564.4		554.6 - 555.1 light tannish gray mostly non porous L.S., frequently jointed changing @ 555.1 to 559.4 to light gray slightly porous L.S. Frequent discontin. plenty of qtz. 559.4 - 564.4 tannish gray L.S. again. Fetted odor.			Recov. 9.8' D.T. = ? W.L. = ø

ENG FORM 1836-A (ER 1110-1-1801) GPO 1960 OF-620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE — Hole No. CS-3

PROJECT — INSTALLATION — SHEET 4 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	564.4		Run (8) 564.4 – 573.75			Dec. 31, 92
			Same tan.-gray L.S. as above w/ fetted odor. mod. porous.			Recov. = 9.35' D.T. = ? W.L. = ø
	573.75		Run (9) 573.75 – 582.1			
			Top .25 same tan.-gray L.S. changing to light gray fine grained unweath. L.S. at 574 – 576 with few vuggs with gray soft shale lenses .5 – 1" thick at top & bottom of that zone then at 576 – 582.1 back to tannish gray porous, sw, L.S.			Recov. = 8.35' D.T. = 60 min W.L. = ø
	582.1		Run (10) 582.1 – 583.9			
			Same tannish gray L.S., less porous than before			Run was cut short due to blockage of water circuit. Need to replace bit.
		583.9				Recov. 1.8'

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF-328-663 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | **Hole No.** CS-3

PROJECT | INSTALLATION – | SHEET 5 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	583.9		Run (11) 583.9 – 594			
			Tannish gray L.S. Nonporous, hard, unweath. w/ plenty of quartz at bottom 2′ especially. Also freq. shale lenses. Top .5′ porous.			Recov. 10.2′ D.T. = 60 min W.L. = ∅
	594		Run (12) 594 – 604.2			
			Same as above getting sw & porous and sltly vuggy at 600.4 to 604.2 with weak fetted odor.			Recov. 10.2′ D.T. = 30 min. W.L. = ∅
	604.2		Run (13) 604.2 – 614.3			
			Same as above. porous to 610.3 then less weath & non porous to end of core			Recov. 10.1 D.T. = 30 min W.L. = ∅

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF-620-605 | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE					Hole No. CS-3
PROJECT		INSTALLATION				SHEET 6 OF SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	614.3		Run (14) 614.3 – 616			
			Inner barrel did not latch & had to be retreived.			Recov. 1.7'
	616		Shaly dark gray L.S., porous with shale lenses.			
			Run (15) 616 – 626.1			
			Dark gray non porous shaly L.S. getting tannish gray, silty. porous at 621 – 625.3 then non porous to end of core.			Recov. 10.1 D.T. = ? W.L. = ϕ
			Run (16) 626.1 – 636.3			
	628.5		626.1 – 628.5 greenish gray limy shale. Getting pure shale at 628.5 – 635.1 635.1 – 636.3 limy shale again.			W.L. = ϕ D.T. = ? Recov. = 10.2' Pres. core: 627.8 – 629.2 629.2 – 630.72 631.55 – 632.5 634 – 635.15 635.15 – 636.3

ENG FORM 1836–A (ER 1110-1-1801) GPO 1968 OF-630-063 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE					Hole No. CS-3
PROJECT			INSTALLATION			SHEET 7 OF SHEETS
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	636.3		Run (17) 636.3 – 639.45			
			Dark greenish gray shale (limy) at top .4 grading to shaly L.S. & to tannish gray L.S. @ 638.1 – bottom			Pres. Core: 636.3 – 638.1
	639.45		BOH 639.45			

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1969 OF-628-663 | PROJECT | HOLE NO.

Hole No. CS-4

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 7 SHEETS

1. PROJECT: UTP	10. SIZE AND TYPE OF BIT: NQ wire line
2. LOCATION (Coordinates or Station): Ft. Knox, KY	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): –
3. DRILLING AGENCY: FMSM	12. MANUFACTURER'S DESIGNATION OF DRILL: B-61
4. HOLE NO. (As shown on drawing title and file number): CS-4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED – UNDISTURBED
5. NAME OF DRILLER: John Serber	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED Dec. 16, 92 COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK: 144.65'	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 643.85	19. SIGNATURE OF INSPECTOR: Ghailan Alsayab

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Hole pre drilled to 499.2' & cased to 95' depth			
	499.2		Run (1) 499.2 – 505.3			
			Dark brown New Albany shale with gray hues. Two soft gray clay zones @ 499.4 – 499.5 and 499.6 – 499.9			Recov. 6.1' D.T. = 35 min W.L. = 100 % Pres. core: 501.45 – 502.2 502.2 – 503.05 503.8 – 504.6
	505.3		Run (2) 505.3 – 515.3			
			New Albany shale w/ pyrite lenses & 1" thick pyrite interbed @ 506.6			Recov. 10' W.L. = 50 % D.T. = 60 min Started loosing water at 510' depth. Pres. core: 507.5 – 508.45 509.4 – 510.3 511.15 – 512.4 512.7 – 513.3 514.1 – 514.7
	515.3					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. CS-4

PROJECT | INSTALLATION | SHEET 2 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	515.3		Run (3) 515.3 - 525.3			
			515.3 - 520 New Albany shale. Dark brown, thinly laminated, unweath. with pyrite lenses. 520 - 525.3 : L.S. light gray, unweath. with fetted odor. L.S. is porous @ 520-522.			Recov. 9.9' Pres. core: 516.25 - 517.45 518.3 - 518.9 518.9 - 519.8 519.8 - 520.8 D.T. = 90 min W.L. = 100 %
	520					
	525.3		RUN (4) 525.3 - 535.5			
			525.3 - 527.9 light gray L.S., non porous, mod. coarse grained. changing to darker gray shaly L.S., unweath, mod. hard, to bottom of core.			Pres. core: 530.55 - 531.4 532.8 - 534.6 534.6 - 535.5 D.T. = 30 min W.L. = 100 % Recovery = 10.2'
	535.3		RUN (5) 535.5 - 545.5			
			Same L.S. as at bottom of last run, shaly.			D.T. = 50 min W.L. = 100 % Recov. 10'

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1968 OF-620-003 | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE | Hole No. CS-4

PROJECT | INSTALLATION | SHEET 3 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Pres. core: 535.85 – 537.05 537.05 – 538 538 – 539.2 542.9 – 544.1
	545.5		Run (6) 545.5 – 555.7 Top foot gray shaly L.S. grading to lt. gray porous L.S. with fetted odor. Vuggy & sltly. weath. More vuggy @ 551.6 – 552			Recov. 10.2' D.T. = 20 min W.L. = 100 % Pres. core: 545.5 – 547
	555.7		Run (7) 555.7 – 565.8 555.7 – 557 light gray porous, vuggy L.S. with fetted odor getting more shaly & less to non porous – with darker gray color 557 – 562. At 562 L.S. gets sltly weath, tannish gray & porous with strong odor.			Recov 10.1' D.T. = 20 min W.L. = 100 %

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1966 OF-620-683 | PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. CS-4
PROJECT	INSTALLATION	SHEET 4 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	565.8		Run (8) 565.8 – 576			
			565.8 – 567.4 porous tannish gray L.S., SW, getting unweath. to 570.3 then SW again to bottom of core odorous.			D.T. = 5 min W.L. = 100 % Recov. 10.2′
	576		Run (9) 576 – 586			
			Top .6′ tannish gray porous L.S., SW, getting darker gray, shaly & mod. coarse grained 576.5 – 578.7 where it has 1″ thick shale bed @ 578.7 and 576.5 (both ends of that shaly zone) then back to tannish gray porous L.S.			D.T. = 20 min. W.L. = 100 % Recov. 10′ * Next day, rods where hung up ~~here~~ @ 486′ and could not be moved up or down. Flushed hole by inserting water hose all way down, used soap & bentonite. Took 2 days.
	586					

ENG FORM 1836-A (ER 1110-1-1801) GPO 1969 OF-620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-4
PROJECT		INSTALLATION	SHEET 5 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	586		Run (10) 586 – 596.2 gray to tannish gray L.S. with lenses of soft gray shale. Non porous, unweath. with quartz. Smooth texture.			Dec 21, 92 stuck on Wed. Freed on Fri Resumed coring on Mon. Dec. 21, 92 Using Revert mud. D.T. = 45 min. W.L. = 100 % Recov. 10.2′
	596.2		Run (11) 596.2 – 606.4 596.2 – 602.5 Same L.S. as above, smooth textured. At 602.5 core gets tannish gray. Rock gets vuggy @ 603.5 – 605 & porous 605 – bottom. 2 broken rock zones where rod dropped while coring at 604.8 – 605 & 605.3 – 605.5 where vuggs caused rock to break.			D.T. = 50 min. W.L. = 100 % Recov. 9.95′ on 10.2′ run
	606.4					

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF - 620-603 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE		Hole No. CS-4		
PROJECT		INSTALLATION		SHEET 6 OF SHEETS	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	606.4		Run (12) 606.4 – 616.7			
			Light tannish gray L.S., weath., porous & vuggy with fetted odor. Changing color @ 614 to cement gray, more porous & corser grained. Deteriorated rock Zone @ 612.6 – 612.8			D.T. = 50 min W.L. = 100 % Recov. 10.2
	616.7		Run (13) 616.7 – 626.85			
			616.7 – 624.3 Same L.S. as at bottom of previous run (cement gray, porous) 624.3 – bottom: gets shaly, with thin lamination, tannish gray L.S. plenty of gray shale lenses.			Recov. 10.2' W.L. = 100 % D.T. = 35 min
	626.85		Run (14) 626.85 – 636.85			
			626.85 – 650 tannish gray, non porous L.S. grading to darker gray shaly L.S. to 632			D.T. = 45 min W.L. = 100 % Recov. 9.9'

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1969 OF - 620-003 PROJECT HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE				Hole No. CS-4
PROJECT		INSTALLATION			SHEET 7 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	632		Then grades to greenish gray shale (Waldron), thinly laminated & fine textured to end of core (i.e. 632' where shale starts)			Pres. Core:
	636.85		Run (15) 636.85 – 643.85			
			Shale (Waldron) as in bottom of previous run changing to tannish gray L.S. at 641.5			Recov. = 7'
			639 – 640.5 shale & L.S. mix.			W.L. = 100 %
	641.5					D.T. = ?
	643.85		BOH			Pres. Core:

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1969 OF-620-003 PROJECT HOLE NO.

BORING NO. CS-5

Project UTP

Date:Start 5/19/93 Complete 6/18/93

Location N Bogie's Hollow E Ft. Knox, Ky

Drilling Agency Boyles Bros

Driller Joe Stidwell Inspector Parsons

Drill Type Failing Hole Master CF-15

Drill Method 9 7/8" bit, 4 3/4" bit, 2 1/4" Core

Thickness of Overburden 35.8'

Depth Drilled into Rock 609.7'

Total Depth of Boring 645.5'

Dir. of Boring X Vert. ____ Inclined ____ Deg

Instrumentation Installed ____

Surface Elevation 701.1' ±

Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION / SURFACE COVER	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
701.1±										
	0–3	Brown, CLAYEY SILT, Moist, Soft to Medium Stiff (0'-3')	ML							9 7/8" Tricone Roller Bit to a depth of 49.5' Installed 6" Sch 80 P.V.C. to a depth of 47 ft, The casing Fell 2.5' when started to use 4 3/4" Hammer Drill. Glued an extension on to P.V.C. Casing Depth of 6" P.V.C. Casing 49.5' w/ 1' Stickup
698.1±	3–5	Reddish Brown to Brownish Red, CLAY, Moist to Damp, Medium Stiff (3'-5')	CH							
696.1±	5–20	Red to Reddish Brown, Cherty CLAY, Damp to Dry, Med Stiff to Medium Stiff (5'-24.8')	CH							2 1/4" Core Christsen NGSWL Core Barrel Using a surface set 25/CT SN 35 Ø 38649 Type Ø2Ø406676

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 1 OF 33

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.c
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled Into Rock ______
Total Depth of Boring ______
Dir. of Boring ______ Vert. ______ Inclined ______ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
691.1±		SURFACE COVER								
	20									
	21									
	22									
	23									
	24									
676.3±	25	Light Red, Fine SANDY CLAY w/ Lenses of CLAYEY Fine SAND Damp to Moist Soft to Med Stiff (24.8'-35.8')	CL/SC							
	26									
	27									
	28									
	29									
	30									
	31									
	32									
	33									
	34									
	35									water encountered at top of Rock
665.3±	36	Top of Rock SHALE, Light Brown to Lt Gray, Soft to Mod. Hard, Weathered, Damp w/ CLAY Seams (35.8 to 62')								
SH	37									
	38									
	39	New Providence Shale								
	40									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N___ E___
Drilling Agency___
Driller___ Inspector___
Drill Type___
Drill Method___
Thickness of Overburden___
Depth Drilled into Rock___
Total Depth of Boring___
Dir. of Boring___Vert.___Inclined___Deg

Instrumentation Installed___
Surface Elevation___
Datum for Surface El.___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
661.1'		SURFACE COVER								
	40									
	41									
	42									
	43									
SH	44									
	45									
	46									
4⅞" bit	47									
	48									
6" Casing 651.6	49									Bottom of 6" P.V.C. Sch 80 Casing Elev 651.6' at 49.5' Changed to 4¾" air hammer drill bit 5/19 5/20
	50									
4¾" Bit	51									
	52									
SH	53									
	54									
	55									
	56									
	57									
	58									
	59									
	60									5/20

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ________ E ________
Drilling Agency ________
Driller ________ Inspector ________
Drill Type ________
Drill Method ________
Thickness of Overburden ________
Depth Drilled into Rock ________
Total Depth of Boring ________
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ________
Surface Elevation ________
Datum for Surface El. ________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
641.1±		SURFACE COVER								
	60									5/21
SH	61									
639.1±	62	Top of Unweathered Rock								
SH	63	SHALE, Lt Gray, Mod Hard, Unweathered, Dry (62'-439')								
	64	New Providence Shale								
	65									
	66									
	67									
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U. T. P.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled Into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
671.1		SURFACE COVER								
	80									
	81									
SH										
	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
	100									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 5 OF 33 SI

BORING NO. CS-5

BORING NO. CS-5

Project W.T.P

Date:Start / / Complete / /

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

Instrumentation Installed

Surface Elevation

Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
601.1		SURFACE COVER								
	100									
	101									
	102									
	103									
	104									
	105									
	106									
	107									
	108									
	109									
	110									
	111									
	112									
	113									
	114									
	115									
	116									
	117									
	118									
	119									
	120									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 6 OF 33 SH A-40

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
581.1		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
SH	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 2 OF 33 A-41

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
561.12		SURFACE COVER								
	140									
	141									
	142									
SH										
	143									
	144									
	145									
	146									
	147									
	148									
	149									
	150									
	151									
	152									
	153									
	154									
	155									
	156									
	157									5/21 5/25
	158									
	159									
	160									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. ____________

Instrumentation Installed____________
Surface Elevation____________
Datum for Surface El.____________

Project ____________
Date:Start __/__/__ Complete __/__/__
Location N____________ E____________
Drilling Agency____________
Driller ____________ Inspector ____________
Drill Type____________
Drill Method____________
Thickness of Overburden____________
Depth Drilled Into Rock____________
Total Depth of Boring____________
Dir. of Boring____ Vert. ____ Inclined____ Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
541.1±		SURFACE COVER								
	160									
	161									
	162									
	163									
	164									
	165									
	166									
	167									
	168									
	169									
	170									
	171									
	172									
	173									
	174									
	175									
	176									
	177									178'± Elev
	178									a 3' Damp Seam
	179									
	180									

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. 55

BORING NO. CS-5

Project U.T.P.

Date:Start / / Complete / /

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

Instrumentation Installed

Surface Elevation

Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
521.1		SURFACE COVER								
	180									
SH	181									
	182									
	183									
	184									
	185									
	186									
	187									
	188									
	189									
	190									
	191									
	192									
	193									
	194									
	195									
	196									
	197									
	198									
	199									
	200									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 10 OF 33 SH A-44

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
501.1		SURFACE COVER								
	200									
	201									
	202									
	203									
SH										
	204									
	205									
	206									
	207									
	208									
	209									
	210									
	211									
	212									
	213									
	214									
	215									
	216									
	217									
	218									
	219									
	220									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

BORING NO.

Project
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
461.1		SURFACE COVER								
	220									
	221									
	222									
SH	223									
	224									
	225									
	226									
	227									
	228									
	229									
	230									
	231									
	232									
	233									
	234									
	235									
	236									
	237									
	238									
	239									
	240									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
461.1		SURFACE COVER								
	240									
	241									
	242									
	243									
	244									
	245									
	246									
	247									
	248									
	249									
	250									
	251									
	252									
	253									
	254									
	255									
	256									
	257									
	258									
	259									
	260									

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Instrumentation Installed ______

Surface Elevation ______

Datum for Surface El. ______

Project U.T.P.

Date:Start / / *Complete* / /

Location N ______ *E* ______

Drilling Agency ______

Driller ______ *Inspector* ______

Drill Type ______

Drill Method ______

Thickness of Overburden ______

Depth Drilled into Rock ______

Total Depth of Boring ______

Dir. of Boring ______ *Vert.* ______ *Inclined* ______ *Deg*

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4411		SURFACE COVER								
	260									
	261									
	262									
	263									
	264									
SH	265									
	266									
	267									
	268									
	269									
	270									
	271									
	272									
	273									
	274									
	275									
	276									
	277									
	278									
	279									
	280									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4211		SURFACE COVER								
	280									
	281									
	282									
	283									
	284									
	285									
	286									
	287									
	288									
	289									
	290									
	291									
	292									
	293									
	294									
	295									
	296									
	297									
	298									
	299									
	300									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled Into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
401.1±		SURFACE COVER								
	300									
	301									
	302									
	303									
	304									
	305									
	306									
	307									
	308									
	309									
	310									
	311									
	312									
	313									
	314									
	315									
	316									
	317									
	318									
	319									
	320									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 16 OF 33 SH___ A-50

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
381.1±		SURFACE COVER								
	320									
	321									
	322									
	323									
	324									
	325									
	326									
	327									
	328									
	329									
	330									
	331									
	332									
	333									
	334									
	335									
	336									
	337									
	338									
	339									
	340									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
361.1		SURFACE COVER								
	340									
	341									
	342									
SH	343									
	344									
	345									
	346									
	347									
	348									
	349									
	350									
	351									
	352									
	353									
	354									
	355									
	356									
	357									
	358									
	359									
	360									

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. 15-5

Project U. T. P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled Into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
341.1		SURFACE COVER								
	360									
	361									
	362									
SH	363									
	364									
	365									
	366									
	367									
	368									
	369									
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 19 OF 33 S. A-53

BORING NO. 15-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
321.1		SURFACE COVER								
	380									
	381									
	382									
	383									
	384									
	385									
	386									
	387									
	388									
	389									
	390									
	391									
	392									
	393									
	394									
	395									
	396									
	397									
	398									
	399									
	400									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
301.1		SURFACE COVER								
	400									
	401									
	402									
	403									5/25
	404									
	405									
	406									
	407									
	408									
	409									
	410									
	411									
	412									
	413									
	414									
	415									
	416									
	417									
	418									
	419									
	420									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
281.1		SURFACE COVER								
	420									
	421									
	422									
	423									
	424									
	425									
	426									
	427									
	428									
	429									
	430									
SH	431									
	432									
	433									
	434									
	435									
	436									
	437									
	438									
262.1±	439									
SH	440	New Albany Shale (Black to Dark Brown Dust)								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 22 OF 33 SH A-56

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
261.1		SURFACE COVER								
	440									
	441									
	442									
	443									
	444									
	445									
	446									
	447									
	448									
	449									
	450									
	451									
	452									
	453									
	454									
	455									
	456									
	457									
	458									
	459									
	460									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
241.1		SURFACE COVER								
	460									
	461									
	462									
	463									
	464									
	465									
	466									
	467									
	468									
	469									
	470									
	471									
	472									
	473									
	474									
	475									
	476									
	477									
	478									Jt - Joint
	479									Sty - Stylolite
	480									Xyln - Crystalline

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency
Driller ____ Inspector ____
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
221.1±	480	SURFACE COVER								
SH	481–482	Start of 2⅛" Core								SH - Shale Ls - Limestone Dol - Dolomite B/P - Bedding Plane Mech - Mechanical Break Geo - Geologist 5/26
SH	483–492	- Pyrite (483.5) - Bedding Plane (485) - pyrite (486) - Mech. Geo (487.5) - silty Vug - pyrite - mech (490) Mech Break - Core spin - mech - mech			100% / 0.99	Box 1	2 1/8			Run 1 5/27 Cored 9.8' Rec 9.8' Loss 0.0' Time 16:30 - 17:00 Waxed Sample / Depth / Elev 1 482.5/487.4 218.6/213.7 2 487.4/489.9 213.7/211.2 Water Return 15% Run 1 to Run 6 Water Loss at Weathered SH at Top of Rock 5/27
	492–500	- Broken Mech - CLAY - B/P CLAY (493) - Mech (New Albany Shale) SHALE, Brown Black to Black Thinly Laminated, Soft to Medium Hard, w/ Occ Siltstone Lenses and Pyrite nodules. - Broken (498.5) - Siltstone (500)			100% / 0.95					Run 2 5/28 Cored 10.3 Rec 10.3 Loss 0.0 Time 9:20 - 10:00 Waxed Sample / Depth / Elev 3 493.7/496.3 207.4/204.8 4 496.3/499.4 204.8/201.7

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-3

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
201.1±		SURFACE COVER								
	500	Jt								
	501	Broken; Broken				Box 2	2 1/8			
	502	Mech								
	503									Run 3 Cored 10.3 Rec 10.3 Loss 0.0 Time 10:50-11:20
	504	Bedding Plane								
	505									
SH	506	Mech			100%/0.90					Waxed Sample / Depth / Elev 5 502.5/503.6 198.6/197.5 6 503.6/504.6 197.5/196.5 7 504.6/506.3 196.5/194.8 8 509.9/512.5 191.2/188.6
	507	Sls Mech; Jt; Broken Mech								
	508	Mech								
	509	Mech								
	510									
	511									
	512	Mech; Siltstone; Mech								
	513	Vertical Jt; Pyrite								
187.5'										Run 4 Cored 10.2 Rec 10.2 Loss 0.0 Time 11:30-12:20
LS	514	Mech Geo (Jeffersonville Limestone)								
	515	Sty; Porous Zone								
	516	Sty Limestone, Tan Brown To Lt Grey, Hard, Fossiliferous, Porous; Sty; SH. Laminae BP			100%/1.0					
	517	SH Laminae BP								
183.1'	518	Mech (Louisville Limestone)								
LS	519	Mech Geo				Box 3				
	520									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-3

BORING NO. ES-5

Project U.T.P.
Date:Start / / Complete / /
Location N_____ E_____
Drilling Agency_____
Driller_____ Inspector_____
Drill Type_____
Drill Method_____
Thickness of Overburden_____
Depth Drilled into Rock_____
Total Depth of Boring_____
Dir. of Boring_____ Vert._____ Inclined_____ Deg

Instrumentation Installed_____
Surface Elevation_____
Datum for Surface El._____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
181.1±		SURFACE COVER								
	520					Box 3				
	521									
	522									
	523	Shale Laminae B/P					2 1/8"			
	524	Mech Geo								Run 5 Cored 10.3 Rec 10.3 Loss 0.0 Time 12:35-13:10
	525	Limestone, Light Gray to Gray, Medium Hard to Hard, Slightly Vuggy to Vuggy, w/ Porous Zones, Stylolites, w/ occ Shale Laminae or Bed.								
Ls	527									
	528	Mech Geo			100% / 1.0					
	529									
	530									
	531	Mech								
	532									
Ls	533	Mech								Run 6 Cored 10.2 Rec 10.2 Loss 0.0 Time 12:55-13:20
	534	Mech Geo								
	535									
	536				100% / 0.96					
	537									
	538	SH Laminae B/P, Mech SH Bedding Plane								
	539	SH Laminae B/P; Mech Geo; SH Laminae Zone B/P				Box 4				
	540	Cemented Jt								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. ES-5

BORING NO. LS-5

Project H.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
161.1±		SURFACE COVER								
160.6'	540	Cemented Jt; Porous Elev 160.6-159.6								Run 6 out of spec for core size
	541					2				
159.5'	542	Vug								
Ls	543	Solution Mech; Mech; Solution; Broken								
	544	B/P Open; Solution								Run 7 Cored 10.3' Rec 10.3' Loss 0.0' Time 13:40-14:45 Water Return 3%
155.6'	545	Sty; Vertical Fracture; B/P Open; Solution; Sty								
	546	B/P Open; V. Porous Elev 155.6±-152.8'								
	547	B/P Open; B/P Open								
152.8'	548	Mech			100% / 0.81					
	549	B/P Open; Solution; B/P Open; 60° Jt								
	550	SH Laminae 0.05' apart B/P; B/P Mech								Out of Spec Core Size
	551	SH Laminae B/P; Open Vugs Solution								
148.3'	552	SH Laminae B/P; SH Laminae B/P; SH								
147.3'	553	Sty; V. Porous Elev 148.3-147.3'; SH Laminae B/P; Mech								
	554	B/P Mech								Run 8 Cored 10.0' Rec 10.0' Loss 0.0'
	555	SH Laminae B/P								
	556	Sty; SH Laminae B/P								Time 15:05-15:42
	557	Open Vug w/ Xstal; Sty; Cemented B/P			100% / 0.95					Out of Spec Core Size
	558	Solution B/P; Mech Geo								Lost all drill water for rest of Boring
	559	Vug; SH 0.01'; SH Laminae B/P								
	560	Sty Mech Geo; SH Laminae B/P; Sty			100% / 0.5					

Piez. Screen

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

\> - PARTIAL LOSS OF DRILL FLUID
\>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 28 OF 33 SH A-62

BORING NO. LS-5

BORING NO. CS-5

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
141.1		SURFACE COVER								
	560	SH Laminae B/P								
		SH 0.02								
	561	Sty								
		Vug SH Laminae B/P					2 1/8			
	562	Sty								
		SH Laminae B/P								
		SH 0.05								
137.8'	563	SH Laminae B/P								
		SH 0.05								
		Vug								
		Mech								
136.8'	564	Fracture Cemented								Run 9
	565	SH 0.02' Mech								Cored 10.3'
		SH Laminae B/P								Rec 10.3
	566									Loss 0.0
	567	SH Laminae B/P								Time 16:05-16:43
		Porous Elev 137.8'-136.8'								
LS	568									Detected H_2S Elev 132.1'
		Core spin								
	569	SH 0.01'			100% / 0.99					
		Core Spin								
	570	60° Cemented Jt								
	571	Vug								
		SH								
		B/P Open Solution								
	572	Core spin								
	573	Mech Geo								
127.0'	574	B/P Open Solution Mech								5/28 6/2
		SH								Run 10
		Sty SH Laminae B/P								Cored 10.3
	575	B/P Open Solution								Rec 10.3
		SH Laminae B/P								Loss 0.0
	576	SH Laminae B/P								
		B/P								
	577	Porous Elev 127.0'-122.9'								Time 8:05-8:50
		Mech Geo								
	578	Mech Geo			100% / 0.99	8 1/6				
122.9'		SH 0.02								
	579									
	580	SH 0.01								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-5

Project U.C.T.

Date: Start / / Complete / /

Location N ____ E ____

Drilling Agency ____

Driller ____ Inspector ____

Drill Type ____

Drill Method ____

Thickness of Overburden ____

Depth Drilled into Rock ____

Total Depth of Boring ____

Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____

Surface Elevation ____

Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
121.1		SURFACE COVER								
	580	SH Laminae B/P SH 0.02'								
	581									
	582						2 ½			
		SH Laminae B/P								
	583	SH 0.03'								
	584	Mech								
	585	SH 0.02'			100%/1.0					Run 11 Cored 10.1 Rec 10.1 Loss 0.0 Time 9:20 - 11:00
	586	Sty; SH Laminae B/P; SH 0.03'								
	587	SH Laminae; Mech Geo								
	588									
LS	589	Sty								
		Sty								
	590	Sty								
	591	SH 0.01'								
	592	Sty								
		Mech Geo								
	593	SH 0.01'								
		Mech Geo								
	594	Sty SH Laminae B/P								
		Sty Mech								
	595	Sty			100%/0.97					Run 12 Cored 10.3 Rec 10.3 Loss 0.0 Time 12:30 - 13:45
	596	Pyrite; SH 0.01'; Sty								
		Sty SH 0.02								
	597	Mech Geo								
		Sty Sty				8 to 7				
	598	B/P Mech								
102.1'	599	Mech; Sty — Cemented Vertical Jt Elev 102.1'-100.8'								
		Vug Mech								
	600	Sty								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION ▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 30 OF 33 SH____

BORING NO. CS-5

BORING NO. CS-5

Project U. T. P.
Date:Start / / Complete / /
Location N____ E____
Drilling Agency____
Driller____ Inspector____
Drill Type____
Drill Method____
Thickness of Overburden____
Depth Drilled into Rock____
Total Depth of Boring____
Dir. of Boring____Vert. ____Inclined____Deg

Instrumentation Installed____
Surface Elevation____
Datum for Surface El.____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
101.1±		SURFACE COVER								
100.8'	600	Sty; B/P								
	601	Vug								
98.8'	602	Mech Geo					2 4/8			
	603	B/P Open; Vug — Porous to V. Porous Elev 98.8' - 92.3'								
	604	Mech; Vug; Mech								
	605	Vug — B/P Open; Vug								Run 13 Cored 10.1 Rec 10.1 Loss 0.0 Time 14:20 - 16:05 Some Testable 4" Sections
LS	606	B/P Open								
	607	Vug								
	608	B/P Open								
92.3'	609									
	610	B/P — SH 0.01'; SH Laminae B/P; Sty			100% / 0.99					
	611	Mech — SH Laminae B/P								
	612	Mech Geo								
	613	SH Laminae B/P; SH 0.03' — SH 0.01'								
Ls	614	SH Laminae B/P								
	615	Sty Mech — Mech; SH Laminae B/P — Xstal Filled Vug; Sty; SH 0.01'								6/2 Run 14 6/3 Cored 10.3 Rec 10.3 Loss 0.0 Time 8:47 - 11:30 Some Testable Sections
	616	Sty — SH Laminae								
	617	Mech Geo			100% / 0.99	Box 8				
	618	Sty — SH 0.01'; Xstal Filled Vug								
	619	SH Laminae B/P; SH 0.01'								
	620	SH 0.01 to 0.03; SH 0.05'								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 31 OF 33

BORING NO. CS-5

BORING NO. CS-5

Instrumentation Installed

Surface Elevation

Datum for Surface El.

Project U.TP

Date: Start / / Complete / /

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
81.1±		SURFACE COVER								
80.7'	620	Mech; Cemented Jt Elev 80.7'-79.7'								
Ls	621	Vug Xstal; SH Laminae AP; Mech Geo								
79.7'	622	Vug, Xstal, Mech								
Ls	623–624	Cemented Jt				2	1/8			
	625	Xstal Filled Vug; SH								
75.9'		Transition Zone w/ SH Elev 75.9'-74.3'								613 / 614
Ls	626	Mech; Mech Geo								Run 15 Cored 9.8 Rec 9.8 Loss 0.0 Time 11:48-14:05
74.3'	627	Mech (Waldron Shale)								Waxed Sample / Depth / Elev
SH	628–634	Mech; SHALE, Dark Green, Medium Hard, Dolomitic. Mech; Mech; Mech; Mech; Mech			100% / 1.0					9: 627.1–627.8, 74.0–73.3 10: 627.8–628.8, 73.8–72.8 11: 628.8–630.0, 72.8–71.1 12: 630.0–631.6, 71.1–69.5 13: 632.5–634.0, 68.6–67.1
66.9'	634	Mech				Box 9				
Dol	635–640	SH Laminae (Laurel Dolomite); Mech; Dolomite, Light Grey to White, Hard w/ Shale; SH 0.02' Laminae and layers. Mech Geo; Mech			100% / 1.0					614 / 618 Run 16 Cored 10.1 Rec 10.1 Loss 0.0 Time 9:30-11:05

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 32 OF 33 SH A-66

BORING NO. CS-5

BORING NO. CS-5

Project U.A.T.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
61.1'		SURFACE COVER								
	640	Sty								
	641						2			
	642									
Dol										
	643	Mech Geo								
	644	Mech Geo								
		Sty								
	645									
46.6'		Mech								
	646	B.O.H.								
	647									
	648									
	649									
	650									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-5

BORING NO. CS-6

Project U.T.P.
Date:Start 6/18/93 Complete / /
Location N Roger's Hollow E Ft. Knox, Ky
Drilling Agency Boyles Bros
Driller Joe Stilwell Inspector Parsons
Drill Type Failing Hole Master CF-15
Drill Method 9 7/8" bit, 4 3/4" bit, 2 1/8" Core
Thickness of Overburden 44.0'
Depth Drilled into Rock 602.8'
Total Depth of Boring 646.8'
Dir. of Boring X Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation 712.8'
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
712.8'		SURFACE COVER								
712.4'		Crushed Gravel (0-0.4')								9 7/8" Tricone Roller Bit to a depth of 49ft
	1	Reddish Brown, SILTY CLAY Moist, Soft to Medium Stiff								Installed 6" Sch 80 P.V.C. to a depth of 49Ft, 1Ft Stickup
	2									
	3									
708.3'	4	(0.4' - 4.5')								
	5	Browish Red to Red, SILTY CLAY, Moist to Damp, Medium Stiff to Stiff								Changed to 4 3/4" air hammer bit at 49'
	6									
	7	(4.5 - 44.0')								
	8									
	9									2 1/8" Core
	10									Christsen NG-SWL Core Barrel
	11									Using a surface set 25 Ct
	12									SN 35Ø 38649
	13									Type Ø2Ø406676
	14									
	15									Changed Drill rigs to Core Joy 22B
	16									
	17									Set NX casing to a Depth of 500' Elev 212.8'
	18									
	19									
	20									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project UTP
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
692.8'		SURFACE COVER								
	20									
	21									
	22									
	23									
	24									
	25									
	26									
	27									
	28									
	29									
	30									
	31									
	32									
	33									
	34									
	35									
	36									
	37									
	38									
	39									
	40									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project U.T.C.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
672.8		SURFACE COVER								
	40									
	41									
	42									
	43									
668.8	44	T.O.R.								
SH		SHALE, Light Gray, Soft to Med Hard								
	45									
	46									
	47									
	48									
	49									
	50									
	51									
	52									
	53									
	54									
	55									
	56									
	57									
	58									
	59									
652.8	60									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled Into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
6528		SURFACE COVER								
LS	60	LIMESTONE, Light Brown to Light Gray, Medium Hard								
	61									
	62									
6498'	63									
SH 649.3		SHALE, Light Brown to Light Gray, Medium Hard								
SS	64	SANDSTONE, Light Brown.								
	65									
6473'										
	66									
SH		SHALE, Lt Gray, Median Hard								
	67									
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80	Good Solid Shale @ 80'								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 4 OF 33 SHE... A-72

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
6328'		SURFACE COVER								
	80									
	81									
	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
6328'	100									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P

Date:Start / / Complete / /

Location N______ E______

Drilling Agency______

Driller______ Inspector______

Drill Type______

Drill Method______

Thickness of Overburden______

Depth Drilled into Rock______

Total Depth of Boring______

Dir. of Boring______Vert. ______Inclined______Deg

Instrumentation Installed______

Surface Elevation______

Datum for Surface El.______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
612.8		SURFACE COVER								
	100									
	101									
	102									
	103									
	104									
	105									
	106									
	107									
	108									
	109									
	110									
	111									
	112									
	113									
	114									
	115									
	116									
	117									
	118									
	119									
	120									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 6 OF 33 SHL A-74

BORING NO. CS-6

BORING NO. CS-6

Project UTP
Date:Start / / Complete / /
Location N________ E________
Drilling Agency________
Driller________ Inspector________
Drill Type________
Drill Method________
Thickness of Overburden________
Depth Drilled into Rock________
Total Depth of Boring________
Dir. of Boring____ Vert. ____ Inclined____ Deg

Instrumentation Installed________
Surface Elevation________
Datum for Surface El.________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5928'		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 2 OF 33 S A-75

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
572.8		SURFACE COVER								
	140									
	141									
	142									
	143									
	144									
	145									
	146									
	147									
	148									
	149									
	150									
	151									
	152									
	153									
	154									
	155									
	156									
	157									
	158									
	159									
	160									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
552.8		SURFACE COVER								
	160									
	161									
	162									
	163									
	164									
	165									
	166									
	167									
	168									
	169									
	170									
	171									
	172									
	173									
	174									
	175									
	176									
	177									
	178									
	179									
	180									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5128		SURFACE COVER								
	180									
	181									
	182									
	183									
	184									
	185									
	186									
	187									
	188									
	189									
	190									
	191									
	192									
	193									
	194									
	195									
	196									
	197									
	198									
	199									
	200									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ________ E ________
Drilling Agency ________
Driller ________ Inspector ________
Drill Type ________
Drill Method ________
Thickness of Overburden ________
Depth Drilled Into Rock ________
Total Depth of Boring ________
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ________
Surface Elevation ________
Datum for Surface El. ________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5/2.8		SURFACE COVER								
	200									
	201									
	202									
	203									
	204									
	205									
	206									
	207									
	208									
	209									
	210									
	211									
	212									
	213									
	214									
	215									
	216									
	217									
	218									
	219									
	220									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 11 OF 33 SH

BORING NO. CS-6

BORING NO. CS-6

Project U. T. P.

Date:Start / / Complete / /

Location N ____ E ____

Drilling Agency ____

Driller ____ Inspector ____

Drill Type ____

Drill Method ____

Thickness of Overburden ____

Depth Drilled into Rock ____

Total Depth of Boring ____

Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____

Surface Elevation ____

Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4928		SURFACE COVER								
	220									
	221									
	222									
	223									
	224									
	225									
	226									
	227									
	228									
	229									
	230									
	231									
	232									
	233									
	234									
	235									
	236									
	237									
	238									
	239									
	240									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4728		SURFACE COVER								
	240									
	241									
	242									
	243									
	244									
	245									
	246									
	247									
	248									
	249									
	250									
	251									
	252									
	253									
	254									
	255									
	256									
	257									
	258									
	259									
	260									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.

Date:Start / / Complete / /

Location N ______ E ______

Drilling Agency ______

Driller ______ Inspector ______

Drill Type ______

Drill Method ______

Thickness of Overburden ______

Depth Drilled into Rock ______

Total Depth of Boring ______

Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ______

Surface Elevation ______

Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
452.8		SURFACE COVER								
	260									
	261									
	262									
	263									
	264									
	265									
	266									
	267									
	268									
	269									
	270									
	271									
	272									
	273									
	274									
	275									
	276									
	277									
	278									
	279									
	280									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 14 OF 33 SHE

BORING NO. CS-6

BORING NO. CS-6

Instrumentation Installed

Surface Elevation

Datum for Surface El.

Project U.T.P.

Date:Start / / Complete / /

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled Into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
432.8		SURFACE COVER								
	280									
	281									
	282									
	283									
	284									
	285									
	286									
	287									
	288									
	289									
	290									
	291									
	292									
	293									
	294									
	295									
	296									
	297									
	298									
	299									
	300									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project A.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4128		SURFACE COVER								
	300									
	301									
	302									
	303									
	304									
	305									
	306									
	307									
	308									
	309									
	310									
	311									
	312									
	313									
	314									
	315									
	316									
	317									
	318									
	319									
	320									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

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BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled Into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
392.8'		SURFACE COVER								
	320									
	321									
	322									
	323									
	324									
	325									
	326									
	327									
	328									
	329									
	330									
	331									
	332									
	333									
	334									
	335									
	336									
	337									
	338									
	339									
	340									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
3728		SURFACE COVER								
	340									
	341									
	342									
	343									
	344									
	345									
	346									
	347									
	348									
	349									
	350									
	351									
	352									
	353									
	354									
	355									
	356									
	357									
	358									
	359									
	360									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
352.8		SURFACE COVER								
	360									
	361									
	362									
	363									
	364									
	365									
	366									
	367									
	368									
	369									
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
372.8		SURFACE COVER								
	390									
	391									
	392									
	393									
	394									
	395									
	396									
	397									
	398									
	399									
	390									
	391									
	392									
	393									
	394									
	395									
	396									
	397									
	398									
	399									
	410									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency
Driller ____ Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
3128		SURFACE COVER								
	400									
	401									
	402									
	403									
	404									
	405									
	406									
	407									
	408									
	409									
	410									
	411									
	412									
	413									
	414									
	415									
	416									
	417									
	418									
	419									
	420									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

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BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled Into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
292.8		SURFACE COVER								
	420									
	421									
	422									
	423									
	424									
	425									
	426									
	427									
	428									
	429									
	430									
	431									
	432									
	433									
	434									
	435									
	436									
	437									
	438									
	439									
	440									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 22 OF 33 SH.

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ______ Vert. ______ Inclined ______ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
2728'		SURFACE COVER								
	440									
	441									
	442									
	443									
	444									
	445									
	446									
	447									
	448									
	449									
	450									
	451									
	452									
	453									
	454									
	455									
	456									
	457									
	458									
	459									
	460									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Instrumentation Installed
Surface Elevation
Datum for Surface El.

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled Into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
252.8'		SURFACE COVER								
	460									
	461									
	462									
	463									
	464									
	465									
	466									
	467									
	468									
	469									
	470									
	471									
	472									
	473									
	474									
	475									
	476									
	477									
	478									
	479									
	480									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 24 OF 33 SH A-92

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
232.8		SURFACE COVER								
	480									
	481									
	482									
	483									
	484									
	485									
	486									
	487									
	488									
	489									
	490									
	491									
	492									
	493									
	494									Sty - Stylolite
	495									Jt - Joint Xyln - Crystalline
	496									Sh - Shale Ls - Limestone
	497									Dol - Dolomite
	498									B/P - Bedding Plane Mech - Mechanical Break
	499									Geo - Geologist SLs - Siltstone
	500									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project: U.T.P.
Date: Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
212.8'		SURFACE COVER								
SH	500–520	500: Mech; Light Gray; 501: Mech; Mech; Mech; 502: Light Gray; Mech; 503: Light Gray; 504: Mech; Core spin — pyrite; 505: Mech; pyrite; 506: SLs 0.01; SLs 0.02; 507: Mech; SLs Mech; 508: SLs Laminae; SLS Lam; 509: Core spin; SLs Laminae; 510: Mech; SLs Laminae; Mech; 511: SLs Laminae — Mech; SLs Laminae; 512: (New Albany Shale) SHALE, Brown Black to Black, Thinly Laminated, Soft to Medium Hard, w/ Occ Siltstone; 514: SLs Laminae Lenses and Mech pyrite nodules; 515: Mech.; 518: Mech — SLs Laminae; 519: SLs Laminae Zone			100% / 1.0 (Run 1); 100% / 1.0 (Run 2); 100% / 1.0 (Run 3)	Box 1; Box 2	2" 1/8			Start 2 1/8 Core with Joy 22 B; Depth 500.1'; Elev 212.7'; Run 1; Cored 9.9 Rec 9.9; Loss 0.0'; Time 8:35 – 9:30; Waxed Sample No / Depth / Elev: 1 502.8–503.9 210.0–208.9; 2 505.0–507.1 207.8–205.7; 3 507.7–508.8 205.1–204.0; 4 508.8–509.6 204.0–203.2; 100% Water Return. Run 2 Cored 4.8' Rec 4.8 Loss 0.0'; Time 11:20 – 14:30; Waxed Sample No / Depth / Elev: 5 511.1–514.7 201.7–198.1; 100% Water Return. Run 3 Cored 5.0 Rec 5.0 Loss 0.0; Time 15:30 – 16:00; Waxed Sample No / Depth / Elev: 6 518.0'–521.4' 194.8'–191.4

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 26 OF 33 SHEETS

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency
Driller ____ Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
1928'		SURFACE COVER								
	520	SLs 0.04; SLs Laminae; SLs 0.04								
1915'	521									
Ls	522–524	(Jeffersonville Limestone) Limestone, Tan Brown to Lt Gray, Hard, Fossiliferous, Porous; Sty; Mech; Sty; Mech					2" 1/8			Trace of Hydrocarbons in Jeffersonville Limestone. Some Sections will not pass wire test for Jeffersonville Limestone
1883	524–535	Shaley Limestone; Mech; Shale; Mech; Sty; BlP Open; Sh Laminae; BlP Open; Sty; Sty; BlP Open; SH 0.02; Argillaceous Porous Limestone; Vert Fracture; BlP; Sh Laminae; Mech Geo; Sh Laminae; Sh Laminae; Mech; Very Argillaceous Limestone; Mech			100% / 0.94	Box 3	/			Run 4 Cored 10.1' Rec 10.1' Loss 0.0 Time 16:30–17:30. 100% Water Return
Ls	535–540	Mech Geo; Mech Geo			100% / 1.0					Run 5 Cored 10.1 Rec 10.1 Loss 0.0 Time 8:30–9:00. 5% Drill return at the Start of run. 90% return at end of run

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. 15-6

Project U.T.P.

Date:Start / / Complete / /

Location N_____ E_____

Drilling Agency_____

Driller_____ Inspector_____

Drill Type_____

Drill Method_____

Thickness of Overburden_____

Depth Drilled into Rock_____

Total Depth of Boring_____

Dir. of Boring_____Vert._____Inclined_____Deg

Instrumentation Installed_____

Surface Elevation_____

Datum for Surface El._____

ELEV.	DEPTH	SOIL CLASSIFICATION / SURFACE COVER	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
172.8										
Ls	540	(Louisville Limestone) Limestone, Light Gray to Gray, Medium Hard To Hard, Slightly Vuggy to Vuggy					2" 4/8			
	541									
	542	Mech w/ Porous Zones, Stylolites, w/ Occ Shale Laminae or								
	543	Mech Bed w/ Occasional Chert nodule								
	544									
	545	Mech								
	546	Sh. Laminae Zone; Mech; Shale Laminae 0.01 to 0.05' apart								Run 6 Cored 10.4 Ft. [illegible] Rec 10.4 Loss 0.0 Time 9:30-10:00
165.3	547	Mech; Porous to Very Porous								
	548	B/P Open; Depth 547.5 Elev 165.3; 558.2 154.6								
	549									
Ls	550	B/P Open; Mech; B/P Open Sol.		100%/0.97	Box 4					Some Sections of core will not part
	551	Sh Laminae Sh 0.01'; Solution								70% Water Return for rest of Boring
	552	Mech; Sty								
	553	B/P Solution; Sty								
	554	Sty B/P; Sty								
	555	Mech								
	556	Mech								Run 7 Cored 10.4 Rec 10.4 Loss 0.0
	557	Mech; B/P Open Solution		100%/0.97						
154.6	558	B/P Open Solution								Time 10:05-10:35
Ls	559	Sh Laminae Sty; Core Spin; Sh Laminae								Core out of spec for some sections
	560	Sty								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. 15-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
152.8'		SURFACE COVER								
LS	560	Sh Laminae Sty; Sh Laminae								
151.8'	561	Vug Mech Sol; Sh Laminae								
	562	Mech; Sh Laminae; Sh 0.03'; Sh 0.01'. Porous Zone: Depth 561.0 – 577.5; Elev 151.8' – 135.3'					2" 1/8			
	563	Sh Laminae								
	564	Sh Laminae; Vug								
	565	Vug; Sty; Sty								
	566	Sty; B/P Sol Core Spin								Run 8 Cored 10.0 Rec 10.0 Loss 0.0 Time 12:30 – 13:30
LS	567–568	Sty; Vug B/P Solution								
	569	Sh 0.03; Sh 0.01; Sty; Sh Laminae; Core Spin								Core out of spec
	570	Sh Laminae								
	571	Vug B/P Solution; Sh Laminae 0.02 – 0.05' apart; B/P			100%/0.99	Box 5				
	573–574	Sty Sol; Sh Laminae; Sh 0.03; B/P Sh Laminae								
	575	B/P Open Solution; Sty								
	576	Mech; Sh Laminae								Run 9 Cored 10.1 Rec 10.1 Loss 0.0
135.3'	577	Sty; Sh 0.05'								Time 13:40 – 14:20
	578–580	Sty; Sh; Sh Laminae			100%/1.0					Occassional Small vugs

Piez screen

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. cs-6

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled Into Rock ______
Total Depth of Boring ______
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
132.8'		SURFACE COVER								
	580	Mech								Some of Core out of Spec
	581	Mech								
		0.05 Chert								
		Sh Laminae								Core in Run 9 has Occassional small vugs
	582	Chert — Sh Laminae								
	583	Chert								
		Sh Laminae								
	584	Sh 0.01								
		Sh Laminae								
	585	Sty					2"			
		Sh 0.01					1/8			
	586	Mech								Run 10
		Sh Laminae/Chert								Cored 4.5'
	587	Sty								Rec 4.35'
Ls	588	0.05' Loss			97%/0.97					Loss 0.15'
		Loss 0.1' — Sh Core Spin								Time 9:45-10:35
	589	Sty								Core out of Spec
	590	Sh 0.01' Sh Laminae								
		Mech								Run 11
	591					Box 6				Cored 5.7'
	592	Sh 0.02'								Rec 5.7'
		Sh Laminae								Loss 0.0'
	593	Chert								Time 11:10-11:40
		Sty Sh 0.01' Mech			100%/1.0					
		Sh 0.02'								
	594	Sh Laminae								
	595	Chert Mech								
		Mech								
		Sh 0.01'								
	596	Sh Laminae								
		Mech Sty								
		Sh 0.01'								Run 12
	597	Sh Laminae								Cored 10.2'
		Sty								Rec 10.2'
	598	Sh Laminae Sh 0.01' w/chert between			100%/1.0					Loss 0.0'
		Chert								Time 12:05-12:30
	599	Sty								
	600	Sh 0.01'								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 30 OF 33 SH...

BORING NO. cs-6

BORING NO. CS-6

Project U.P.T.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
112.8		SURFACE COVER								
	600	Mech; Sty								
		Sh B/P Core Spin								
	601	Sh Laminae; Sty								
	602									
		Sty								
Ls	603	Core Spin; Sty Sh Laminae								Change bit for Run 13
	604	Sty Core Spin; Sty								Christensen Impregnated Type Ø2Ø4Ø 5132
		Mech								CBit NGSWL 2.985
	605	Sh Laminae; Sty								Green
	606	B/P Sty; Sh Laminae								SN: 35-037574
105.6	607	Sty; Sty Mech; B/P Open; Core Spin								Run 13
		B/P Core Spin; Vug; Porous to Very Porous								Cored 10.2
	608	Core Spin; Depth 607.2 615.0'; Elev 105.6 97.8					2			Rec 10.0'
	609	Solution; Core Loss 0.2'					1/4			Loss 0.2'
		Solution Mech								Time 12:40-13:30
Ls	610	Core Spin; Solution; Core Spin				Box 7				Core from 606.4 to 607.2 off size cut to being cored twice. Driller change core bits and was raising and [illegible] drill string
	611	Core Spin								
		B/P Open								
	612	B/P Open								
	613	B/P Open			98%/0.90					H_2S odor in porous zone
	614	Spin Solution								Core Loss between core spins
97.8	615	B/P Open; Sh 0.01'								
		Sty Core Spin; Sh Laminae								
	616	Sty Sh 0.01'; Sty								
		Sh Laminae Mech								
Ls	617	Core Spin								Run 14
	618				100%/1.0					Cored 10.0; Rec 10.0; Loss 0.0
	619	B/P W/Sh Sh 0.02'; Sty Mech								Time 13:40-14:30
	620	Sty B/P Open								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-6

Project U.P.T.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled Into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION / SURFACE COVER	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
92.8'	620	Sty								NQ Found to be hung on 6128 Removed NX Casing and overdrilled NQ Casing w/ 3½" O.D. Casing to a depth of 616.0' Elev 96.8'
	621	Sh Laminae; Sh 0.01 to 0.03								
		Core Spin; Sh 0.01								
	622	Sh 0.02								
	623									
	624	Sh Laminae Mech; Mech Geo								
Ls	625	Mech; Sh Laminae; Sty; Sh Laminae 0.01 to 0.07' 0.01 to 0.05 apart								
	626									7/6
	627	Mech; Sh Laminae Mech; Vug					2"			Run 15 Cored 9.9' Rec 9.9' Loss 0.0
	628	B/P Mech; B/P					1/8			
	629	Mech								Time 8:40 – 10:20
	630	Sh Mech				8, 7, 8				
	631	Sh Zone 0.01 – 0.03'								Waxed Sample No / Depth / Elev: 7 / 632.5–633.9 / 80.3–78.9; 8 / 634.4–636.2 / 78.4–76.6
80.3'	632	Mech								
	633	(Waldron Shale)			100%/1.0					
SH	634	Mech; SHALE, Dark Green, Medium Hard, Dolomitic								
	635	B/P								
	636									
	637									Run 16 Cored 10.7 Rec 10.7 Loss 0.0
	638	Mech			100%/1.0					
	639									Time 10:30 – 11:10
	640									

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 22 OF 33 SH A-100

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
72.8'		SURFACE COVER								
SH	640									
71.4'	641									Waxed Sample No / Depth / Elev
	642	(Laurel Dolomite)					2" / 8			
Dol	643	Mech Sty								9 / 636.2 – 638.3 / 76.6 – 74.5
	644	Dolomite, Light Gray to White, Hard w/ Shale Laminae and layers w/								10 / 638.3 – 642.9 / 74.5 – 69.9
	645	Sty Occussional Stylolite and Dark Bands								
	646									
66.0'		Sty Sh 0.03'								
	647	B.O.H.								
	648									
	649									
	650									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-6

BORING NO. CS-7

Project U.T.P.
Date: Start 6/15/93 Complete 7/12/93
Location N Reece's Hollow E Ft. Knox, Ky
Drilling Agency Bayles Bros
Driller Joe Stillwell Inspector Parsons
Drill Type Failing Hole Master CF-15
Drill Method 9 7/8" bit, 4 3/4" bit, 2 7/8" core
Thickness of Overburden 39.0'
Depth Drilled into Rock 597.7'
Total Depth of Boring 636.7'
Dir. of Boring X Vert. ____ Inclined ____ Deg

Instrumentation Installed
Surface Elevation 706.9
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
706.9		SURFACE COVER								
	0–4	Lt Brown, SILTY CLAY, Wet, Soft to Medium Stiff (0-4')								9 7/8" Tricone Roller Bit to a depth of 43'. Installed 6" Sch 40 P.V.C. to a depth of 43 Ft.
702.9	4	Limestone, Boulder (4-5')								
701.9	5	Reddish Brown to Dark Red, SILTY CLAY w/ Chert Fragments, Damp to Moist, Stiff to Very Stiff (5-15')								2 7/8 Core drilled using a Joy 22B and 3 1/2" Casing from 495 to Surface. 2 7/8" Core (495'-535') Christsen Impregnated bit Type Ø 2Ø4Ø5132 C'Bit NGSWL 2,985 RSG Green SN 35-037574 (535'-636.7') Impregnated Bit C'Bit NGSWL 2,985 RSG Green. SN 35Ø386Ø4
691.9'	15	Reddish Brown, Fine SANDY SILTY CLAY, Moist, Stiff (15-39')								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. ____________

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
686.9		SURFACE COVER								
	20									
	21									
	22									
	23									
	24									
	25									
	26									
	27									
	28									
	29									
	30									
	31									
	32									
	33									
	34									
	35									
	36									
	37									
	38									
667.9	39	T.O.R.								
SH	40	SHALE, Lt Gray to Tan, Soft, w/ Occasional Clay Seams								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 2 OF 32 SHE A-104

BORING NO. CS-7

BORING NO. ____________

Project U.T.P.
Date:Start / / Complete / /
Location N________ E________
Drilling Agency________
Driller________ Inspector________
Drill Type________
Drill Method________
Thickness of Overburden________
Depth Drilled into Rock________
Total Depth of Boring________
Dir. of Boring____Vert.____Inclined____Deg

Instrumentation Installed________
Surface Elevation________
Datum for Surface El.________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
666.9		SURFACE COVER								
	40									
	41									
	42									
	43									
	44									
	45									
	46									
SH	47									
	48									
	49									
	50									
	51									
	52									
	53									
652.9	54	CLAY Seam 4"								
651.9	55	CLAY Seam 3"								
	56									
	57									
	58	(39-58)								
	59	Lt Gray, Shale, Unweathered Medium Hard to Soft,								
	60	(58-60)								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 3 OF 32 S. A-105

BORING NO. CS-7

BORING NO. ______

Project U.T.P.
Date:Start / / Complete / /
Location N______ E______
Drilling Agency______
Driller ______ Inspector ______
Drill Type______
Drill Method______
Thickness of Overburden______
Depth Drilled into Rock______
Total Depth of Boring______
Dir. of Boring____ Vert. ____ Inclined ____ Deg

Instrumentation Installed______
Surface Elevation______
Datum for Surface El.______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
646.9		SURFACE COVER								
SS	60	Lt Brown to Brown, Sandstone								
	61									
	62									
643.9	63	(60-63)								
SH	64	Lt Gray, Shale, Medium Hard, w/ Occassional Joint and Chert nodule, (63'-434')								
	65									
	66	New Providence Shale								
	67									
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 4 OF 32 SHI A-106

BORING NO. CS-7

BORING NO. ________

Project ______ U.T.P. ______
Date:Start __/__/__ Complete __/__/__
Location N__________ E__________
Drilling Agency__________
Driller__________ Inspector__________
Drill Type__________
Drill Method__________
Thickness of Overburden__________
Depth Drilled into Rock__________
Total Depth of Boring__________
Dir. of Boring_____ Vert. _____ Inclined_____ Deg

Instrumentation Installed__________
Surface Elevation__________
Datum for Surface El.__________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
626.9		SURFACE COVER								
	80									
	81									
	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
	100									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project UTP

Date:Start / / Complete / /

Location N ____ E ____

Drilling Agency ____

Driller ____ Inspector ____

Drill Type ____

Drill Method ____

Thickness of Overburden ____

Depth Drilled Into Rock ____

Total Depth of Boring ____

Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____

Surface Elevation ____

Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
606.9		SURFACE COVER								
	100									
	101									
	102									
	103									
	104									
	105									
	106									
	107									
	108									
	109									
	110									
	111									
	112									
	113									
	114									
	115									
	116									
	117									
	118									
	119									
	120									

SYMBOLS: ▽ - WATER LEVEL AT COMPLETION
▼ - WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 6 OF 32 SHEETS

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5869		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
566.9		SURFACE COVER								
	140									
	141									
	142									
	143									
	144									
	145									
	146									
	147									
	148									
	149									
	150									
	151									
	152									
	153									
	154									
	155									
	156									
	157									
	158									
	159									
	160									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 8 OF 32 SH A-110

BORING NO. CS-7

BORING NO. CS-1

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
546.9		SURFACE COVER								
	160									
	161									
	162									
	163									
	164									
	165									
	166									
	167									
	168									
	169									
	170									
	171									
	172									
	173									
	174									
	175									
	176									
	177									
	178									
	179									
	180									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 9 OF 32 A-111

BORING NO. CS-7

BORING NO. 15-7

Project U.T.P.
Date:Start / / Complete / /
Location N_____ E_____
Drilling Agency_____
Driller_____ Inspector_____
Drill Type_____
Drill Method_____
Thickness of Overburden_____
Depth Drilled into Rock_____
Total Depth of Boring_____
Dir. of Boring_____Vert._____Inclined_____Deg

Instrumentation Installed_____
Surface Elevation_____
Datum for Surface El._____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5269		SURFACE COVER								
	180									
	181									
	182									
	183									
	184									
	185									
	186									
	187									
	188									
	189									
	190									
	191									
	192									
	193									
	194									
	195									
	196									
	197									
	198									
	199									
	200									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. 15-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
506.4		SURFACE COVER								
	200									
	201									
	202									
	203									
	204									
	205									
	206									
	207									
	208									
	209									
	210									
	211									
	212									
	213									
	214									
	215									
	216									
	217									
	218									
	219									
	220									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. 15-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4864		SURFACE COVER								
	220									
	221									
	222									
	223									
	224									
	225									
	226									
	227									
	228									
	229									
	230									
	231									
	232									
	233									
	234									
	235									
	236									
	237									
	238									
	239									
	240									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 12 OF 32 SHEETS

BORING NO. 15-7

BORING NO. CS-1

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

Project U.T.P.
Date: Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4669		SURFACE COVER								
	240									
	241									
	242									
	243									
	244									
	245									
	246									
	247									
	248									
	249									
	250									
	251									
	252									
	253									
	254									
	255									
	256									
	257									
	258									
	259									
	260									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CC-7

Project H.T.P.
Date: Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
446.9		SURFACE COVER								
	260									
	261									
	262									
	263									
	264									
	265									
	266									
	267									
	268									
	269									
	270									
	271									
	272									
	273									
	274									
	275									
	276									
	277									
	278									
	279									
	280									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CC-7

BORING NO. CS-7

Project U.T.P.

Date:Start / / Complete / /

Location N ____ E ____

Drilling Agency ____

Driller ____ Inspector ____

Drill Type ____

Drill Method ____

Thickness of Overburden ____

Depth Drilled into Rock ____

Total Depth of Boring ____

Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____

Surface Elevation ____

Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4264		SURFACE COVER								
	280									
	281									
	282									
	283									
	284									
	285									
	286									
	287									
	288									
	289									
	290									
	291									
	292									
	293									
	294									
	295									
	296									
	297									
	298									
	299									
	300									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 15 OF 32 SH A-117

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ______ Vert. ______ Inclined ______ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
406.9		SURFACE COVER								
	300									
	301									
	302									
	303									
	304									
	305									
	306									
	307									
	308									
	309									
	310									
	311									
	312									
	313									
	314									
	315									
	316									
	317									
	318									
	319									
	320									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ______ Vert. ______ Inclined ______ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
3864		SURFACE COVER								
	320									
	321									
	322									
	323									
	324									
	325									
	326									
	327									
	328									
	329									
	330									
	331									
	332									
	333									
	334									
	335									
	336									
	337									
	338									
	339									
	340									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 17 OF 32

BORING NO. CS-7

BORING NO. 15-7

Project W.T.P.

Date:Start / / Complete / /

Location N___ E___

Drilling Agency___

Driller___ Inspector___

Drill Type___

Drill Method___

Thickness of Overburden___

Depth Drilled Into Rock___

Total Depth of Boring___

Dir. of Boring___ Vert. ___ Inclined___ Deg

Instrumentation Installed___

Surface Elevation___

Datum for Surface El.___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
366.9		SURFACE COVER								
	340									
	341									
	342									
	343									
	344									
	345									
	346									
	347									
	348									
	349									
	350									
	351									
	352									
	353									
	354									
	355									
	356									
	357									
	358									
	359									
	360									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 18 OF 32 SHEETS A-120

BORING NO. 15-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N______ E______
Drilling Agency______
Driller______ Inspector______
Drill Type______
Drill Method______
Thickness of Overburden______
Depth Drilled Into Rock______
Total Depth of Boring______
Dir. of Boring______ Vert.______ Inclined______ Deg

Instrumentation Installed______
Surface Elevation______
Datum for Surface El.______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
346.9		SURFACE COVER								
	360									
	361									
	362									
	363									
	364									
	365									
	366									
	367									
	368									
	369									
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 14 OF 32 SHEETS

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N_____ E_____
Drilling Agency_____
Driller _____ Inspector _____
Drill Type_____
Drill Method_____
Thickness of Overburden_____
Depth Drilled into Rock_____
Total Depth of Boring_____
Dir. of Boring_____ Vert. _____ Inclined_____ Deg

Instrumentation Installed_____
Surface Elevation_____
Datum for Surface El._____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
3264		SURFACE COVER								
	380									
	381									
	382									
	383									
	384									
	385									
	386									
	387									
	388									
	389									
	390									
	391									
	392									
	393									
	394									
	395									
	396									
	397									
	398									
	399									
	400									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ________ E ________
Drilling Agency ________
Driller ________ Inspector ________
Drill Type ________
Drill Method ________
Thickness of Overburden ________
Depth Drilled Into Rock ________
Total Depth of Boring ________
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ________
Surface Elevation ________
Datum for Surface El. ________

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
306.4		SURFACE COVER								
	400									
	401									
	402									
	403									
	404									
	405									
	406									
	407									
	408									
	409									
	410									
	411									
	412									
	413									
	414									
	415									
	416									
	417									
	418									
	419									
	420									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date: Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
286.9		SURFACE COVER								
	420									
	421									
	422									
	423									
	424									
	425									
	426									
	427									
	428									
	429									
	430									
SH	431									
	432									
	433									
272.9	434	New Albany Shale, SHALE, Brown-Black to Black, Thinly Laminated, Soft to Medium Hard, w/ Occ Siltstone Lenses and pyrite nodules								
	435									
SH	436									
	437									
	438									
	439									
	440									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled Into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
		SURFACE COVER								
2669	440									
	441									
	442									
	443									
	444									
	445									
	446									
	447									
	448									
	449									
	450									
	451									
	452									
	453									
	454									
	455									
	456									
	457									
	458									
	459									
	460									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION

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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Instrumentation Installed
Surface Elevation
Datum for Surface El.

Project U.T.P.
Date: Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
246.9		SURFACE COVER								
	460									
	461									
	462									
	463									
	464									
	465									
	466									
	467									
	468									
	469									
	470									
	471									
	472									
	473									Ls = Limestone Dol = Dolomite Sh = Shale Sty = Stylolite Xstal = Crystalline B/P = Bedding plane Mech = Mechanical Break Geo = Geologist
	474									
	475									
	476									
	477									
	478									
	479									
	480									

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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date: Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
2769		SURFACE COVER								
	480									Core is Very Bad From 495 to 509.5 due to bent Core Barrel. The inner barrel would not latch properly
	481									
	482									
	483									Waxed Sample No / Depth / Elev
	484									1 / 497.3–497.9 / 209.6–209.0
	485									
	486									2 / 500.9–501.7 / 206.0–205.2
	487									3 / 501.9–503.1 / 205.0–203.8
	488									4 / 505.4–506.8 / 201.5–200.1
	489									5 / 507.3–508.4 / 199.6–198.5
	490	RQD in Runs 1, 2 and 3 not determined due to poor core caused by a bent core barrel								6 / 508.6–509.5 / 198.3–197.4
	491									
SH	492									7 / 509.9–511.5 / 197.0–195.4
	493									8 / 511.5–512.5 / 195.4–194.6
	494									9 / 512.3–513.2 / 194.6–193.7
211.9'	495	Start 2 1/8 Core								
		Broken mech								Run 1 Cored 4.9 Rec 2.9 Loss 0.0 (Full waxed sample)
	496	mech (New Albany Shale)				Box 1	2 1/8"			
SH	497	mech SHALE, Brown Black to								
209.6		mech Black, Thinly Laminated,								Time 11:10 – 12:30
209.0	498	mech Soft to Medium Hard, Siltstone w/ occ Siltstone Lenses								
		Broken Mech (core spins) and pyrite nodules								Left 2' of core in Bottom of hole
	499	Pyrite			100%					
		mech								100% Drill water Return
	500	Broken Mech								

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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ______ E ______
Drilling Agency ______
Driller ______ Inspector ______
Drill Type ______
Drill Method ______
Thickness of Overburden ______
Depth Drilled into Rock ______
Total Depth of Boring ______
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ______
Surface Elevation ______
Datum for Surface El. ______

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
206.9		SURFACE COVER								
	500	Mech; Jt; Core spin								Run 2 Waxed Samples Cored 3.3 2 and 3 Rec 1.5 100% Drill Loss 0.0 Water Return Time 12:45-13:15
	501	pyrite; Mech; Spin; Pyrite								
	502				100%/—					Left 1.5 of Core in Bottom of hole
	503	Siltstone Laminae; Mech — Broken Mech; Core Loss; Core Spin								Run 3 Waxed Samples 4, 5 and 6 Cored 6.3 Rec 4.95 100% Drill Loss 1.35 water Return Time 13:30-[illegible]
	504	Undersize								
	505	Spin; Core Loss								Inner barrel didn't latch due to [illegible] core barrel causing poor core recovery and poor core condition. Rods pulled
	506	pyrite; pyrite nodules; Mech					4 2 1/8			
	507									
	508	Core Spin Core Loss			79%/—					
	509	pyrite; Core Spin; pyrite Mech								Run 4 Core barrel fixed Cored 5.3 Rec 5.3 Loss 0.0 Time 11:45-12:10
	510	pyrite								
	511	Mech								
	512	mech; prite and Siltstone Laminae			100%/1.0	Box 2				100% Drill water return in Shale, Drill water Losses started to occur at end of run in Limestone
193.3	513	Mech; pyrite								
Ls	514	Jeffersonville Limestone; Sty; mech								Run 5 Cored 10.3 Rec 10.3 Loss 0.0 Time 12:30-13:50
	515	B/P open Hydrocarbons; B/P open present in Jeffersonville Ls								
	516									
191.2	517	Sh Laminae B/P Open; Very Argillaceous; B/P Sh 0.03; Porous Zone Depth 513.6 515.7 Elev 193.3 191.2			100%/1.0					
Ls	518	Sh Laminae								
	519	Sh Laminae; Sty Sh 0.01; Sh 0.01								
	520	Sty								0 Drill water Return

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
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ORL FORM 1202
1 June 1988

BORING NO. C-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N ____ E ____
Drilling Agency ____
Driller ____ Inspector ____
Drill Type ____
Drill Method ____
Thickness of Overburden ____
Depth Drilled into Rock ____
Total Depth of Boring ____
Dir. of Boring ____ Vert. ____ Inclined ____ Deg

Instrumentation Installed ____
Surface Elevation ____
Datum for Surface El. ____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
Ft/ft 9		SURFACE COVER								
LS	520	Limestone, Tan Brown to Lt Gray, Hard, Fossiliferous, Porous w/ Hydrocarbon								
	521	– B/P								
		– B/P Sh 0.01 Sh Laminae								
	522	– Very argillaceous Black porous								
		Louisville Limestone								
	523	– B/P								
	524									
	525	– Mech					2"			
LS	526	– Mech Geo					1/4			Run 6 Cored 10.2 Rec 10.2 Loss 0.0 Time 14:00 – 14:35
		– Mech								
	527									
		– Mech								
	528									
	529	– Mech Geo								
	530	– Mech Geo								
		– Mech Geo								
	531	Limestone, Light Gray to Gray, Medium Hard to Hard, Slighty Vuggy to Vuggy w/ Porous Zones, Stylolites, w/ Occ shale Laminae or Bed w/ Occ Stringer of Dolomite			100% / 11.0	Box 3				
	532									
	533									
	534	– Mech								20% Drill water Return
	535	– Mech								
	536				100% / 11.0					Run 7 Cored 10.0 Rec 10.0 Loss 0.0 Time 14:45 – 15:20 H2S Odor Changed Bits
	537	– Mech								
	538	– B/P0								
	539	– Mech								
	540	– Sh Laminae 0.01 to 0.03 apart								

Rez size (525–530)

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
166.4		SURFACE COVER								
Ls	540	Mech; Sh Laminae 0.01 to 0.03' apart; Mech								
	541	Mech								
	542	B/P Opn								
164.3		Porous to Very Porous Zone								
Ls	543	B/P Opn Solution; Depth 542.6 / 552.6, Elev 164.3 / 154.3								
	544	Vug; Sty								
	545	B/P Solution; B/P Opn w/ Xstall; B/P Opn; Sty; Vertical Fracture								Run 8 Cored 10.3 Rec 10.3 Loss 0.0 Time 7:30-8:30
	546									
	547	B/P Sh Laminae; B/P Vertical Fracture					2"			
	548	B/P Opn; Sh Laminae					1/8			20% Drillwater return
	549	B/P Open Solution; Sty								
	550	Core Spin								
		B/P Opn				BX4				H2S Odor
	551	B/P Opn; B/P w/ Weathered Sh; Sty			100%/10.3					
	552	Sh Laminae; Sty; Sty; Sh Laminae								
154.3		Sh 0.01'								
	553	Sh Laminae; Sh Laminae								
Ls	554	Vug Mech								
	555	Mech Sh Laminae								
	556	Sh Laminae; Sh Laminae; Sh Laminae Mech; Sh 0.03'								Run 9 Cored 10.2 Rec 10.2 Loss 0.0
	557	Sty; Sh Laminae; Sty; Vug								
149.1		Porous to Very Porous Zone; Depth 557.8 / 561.9, Elev 149.1 / 145.0			100%/10.0					Time 9:10-9:37
Ls	558									
	559	Sty; B/P Opn; Vug								20% Drill water Return H2S Odor

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BORING NO. CS-7

Project UiTiPi
Date: Start / / Complete / /
Location N ___ E ___
Drilling Agency ___
Driller ___ Inspector ___
Drill Type ___
Drill Method ___
Thickness of Overburden ___
Depth Drilled into Rock ___
Total Depth of Boring ___
Dir. of Boring ___ Vert. ___ Inclined ___ Deg

Instrumentation Installed ___
Surface Elevation ___
Datum for Surface El. ___

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
146.9		SURFACE COVER								
Ls	560	B/P Open Solution								
	561	B/P Open Solution; Sty; Fracture 80°								
145.0'	562	Core Spin Sh 0.03'; ShLaminae; ShLaminae Mech; ShLaminae								
	563	Sty; Sh 0.01'								
Ls	564	ShLaminae; ShLaminae Mech; Mech; Sty								
	565	ShLaminae 0.03 apart; Mech Sh Laminae; ShLaminae; Sty Mech					2"			
140.9	566	Vug Xstall; Vug; B/P Open					1/8			Run 10 Cored 10.3 Rec 10.0 Loss 0.3 Time 9:55 - 10:35
	567	Sh 0.04'; Sty Open; Vertical Fracture Open								
	568	Sty Open; Core Spin Open								
	569	B/P Open								
	570	B/P Open; Core Spin Sh 0.04'; Core Loss 0.2'				Box 5				
	571	Vug			97% / 0.70					Some Sections of Core will not pass specs.
	572	Vertical Fracture Open								
Ls	573	Sh; Core Spin 0.1 Core Loss								
	574	B/P Open								No Drill water Return for the rest of bor...
	575	Sty Open; Sty Open								
	576	Sty Mech; ShLaminae 0.01 to 0.03' apart; ShLaminae								Run 11 Cored 10.1 Rec 10.1 Loss 0.0 Time 10:45-11:40
	577	Vug			100% / 1.0					
	578	Sty								
	579	B/P Open Solution								
	580									

Porous Zone

Depth	Elev
566.0'	140.9'
580.9'	126.0'

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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.

Date: Start / / Complete / /

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

Instrumentation Installed

Surface Elevation

Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
126.9		SURFACE COVER								
	580	Sty								
126.0'	581	Sh 0.1' w/ Core Spin								
	582									
	583	Sty Sh 0.02'								
	584	pyrite Mech								
		Core Spin Sh 0.05'								
	585									
	586	Sty; Sh Laminae; Sty 0.03' Sh; Sh Laminae Mech								
Ls	587				100% / 1.0	Box 6	2 1/8			Run 12 Cored 10.3 Rec 0.0 Loss 0.0 Time 13:20-14:35
	588	Chert Sh Laminae; Chert								
	589	Mech; Sty; Sh 0.01' Mech								
	590	Sh Laminae; Sh 0.03 w/ Core Spin								
	591	Sty w/ Core Spin								
	592	Sh 0.02' Mech								
	593	BIP w Core Spin								
	594	Mech, Sh 0.01'; Sh Laminae Mech								
	595									
	596	Sty; Sty; Sty; Mech; Sh Laminae			100% / 0.97					Run 13 Cored 9.8 Rec 9.8 Loss 0.0 Time 14:50-15:35
	597	Sty; Mech								
	598	Sty; Mech								
	599	Sty Sh Laminae								
107.4'		Sty; Sty Open								
	600	Sty								

Porous Zone

Depth	Elev
599.5'	107.4'
621.7'	85.2'

SYMBOLS: ▽ WATER LEVEL AT COMPLETION ▼ WATER LEVEL ___ HOURS AFTER COMPLETION

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ORL FORM 1202
1 June 1988

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N______ E______
Drilling Agency______
Driller ______ Inspector ______
Drill Type______
Drill Method______
Thickness of Overburden______
Depth Drilled into Rock______
Total Depth of Boring______
Dir. of Boring____Vert. ____Inclined____Deg

Instrumentation Installed______
Surface Elevation______
Datum for Surface El.______

ELEV.	DEPTH	SOIL CLASSIFICATION / SURFACE COVER	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
106.4										
	600	B/P Open Solution Vug								
		Solutioning Broken								
	601	B/P Solutioning Vug								
		B/P Solutioning w/ Core Spin								
	602	B/P Solutioning								
	603	B/P Solutioning Mech								
		Mech								
	604	Solutioning								
		B/P Open w/ xstall Vug								
	605	B/P Open Solution								
	606	Mech								
		Mech								
	607	Sty Sh 0.01' Weathered			100%/100	29				Run 14 Cored 9.8 Rec 9.8 Loss 0.0 Time 8:10-8:40
		Sh Laminar								
	608	Sty Mech				Box 7	1/8			
	609	B/P Open Sh 0.01' Sty								
	610									
Ls	611	Sty Core Spin								
	612	Sty Sh 0.01'								
		Core Spin								
	613	Mech								
		Sh Laminar Mech								
	614	Sh 0.01' Sh Sty								
		Sh								
	615	Sh 0.03'								
		Sty								
	616	Sh Laminar								
		Sh Laminar Mech			100%/40					Run 15 Cored 10.2 Rec 10.2 Loss 0.0 Time 8:50-9:30
	617	Core Spin								
		Sh Laminar Mech								
		Sh Laminar								
	618	Sh								
		Sty								
	619									
	620	B/P w/ Sh Laminar Mech								

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ORL FORM 1202
1 June 1988

SHEET 31 OF 32

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
Date:Start / / Complete / /
Location N E
Drilling Agency
Driller Inspector
Drill Type
Drill Method
Thickness of Overburden
Depth Drilled into Rock
Total Depth of Boring
Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
Surface Elevation
Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
86.9		SURFACE COVER								
	620	Vug, Xstall								
	621	BIP Open								
	622	Mech								
		Mech Sh 0.03'								
	623	Sh 0.01'								
		Xstall								
	624	Transition Zone Very Argillceous								
82.1'							2			
	625	Waldron Shale					1/8			
	626	mech SHALE, Dark Green, Medium Hard, Dolomitic								Run 14 Cored 10.4 Rec 10.4 Loss 0.0 Time 9:50-10:30; Pulled Bottom of Core run
SH	627	Mech								
	628	Mech				Box 8				
		Mech and Off size core								
	629									
	630	Mech								Waxed Sample No / Depth / Elev
	631	Off size Core			100%/1.0					11 / 628.1–628.7 / 78.8–78.2
	632									12 / 628.7–630.5 / 78.2–76.4
	633	Off size Core								13 / 630.9–633.6 / 76.0–73.3
		Mech								
72.7'	634	Laurel Dolomite								
Dol	635	Sh 0.01 sty; Dolomite, Light Gray to White, Hard w/ Shale Laminae and Stylolites								
	636	Mech								
70.2'		Mech								
	637	B.O.H.								
	638									
	639									
	640									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ___ HOURS AFTER COMPLETION
> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

JOINT CLASSIFICATION LOG

DATE: Dec. 10, 92

ELEV. TOP OF HOLE ________ PROJECT NAME ________ CORE BORING NO. CS-1

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
RUN 1	491.6 -	496.3									
1	492.15			P	0°	Polished	mt	No	No	Un	
2	494.05			P	0°	sm	mt	"	"	SW	
3	494.5			P	0°	pl	mt	"	"	Un	
4	494.55			P	0°	pl	mt	"	"	"	
5	494.6			P	0°	pl	"	"	"	"	
6	495			P	10°	sm	"	"	"	SW	
RUN 2	496.3 -	506.3									
1	496.1			P	0°	sm	mt	No	No	Un	
2	496.4			P	0°	"	"	"	"	"	
3	497.4			P	5°	"	"	"	"	"	
4	498.3			P	0°	SR	"	"	"	"	SR: slightly rough
5	499.9			U	0°	sm	"	"	"	"	
6	501			P	0°	sm	"	"	"	"	
7	501.55			U	10°	SR	"	"	"	"	
8	502.7			P	10°	sm	"	"	"	"	mB ?
9	503.95			P	0°	pl	"	"	"	"	
10	505			P	0°	pl	"	"	"	"	
RUN 3	506.3 -	516									
1	506.72			P	0°	sm	Open	No	No	Un	
2	506.72 -	508									MB (vertical break)
3	508.4			P	15°	SR	O	"	"	"	
4	509 -	510		P	90°	R	O	"	"	SW	Vertical Jt.

JOINT CLASSIFICATION LOG

DATE: Dec. 10, 92

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-1

PAGE 2

JOINT NO.	DEPTH	ELEX.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
5	511.7			P	0°	SR	mt	No	No	Un.	
	514.4										mB
RUN 4	516 -	526									
1	515.22			P	0°	R	Open	No	calcite	Un	
2	516			P	0°	SR	"	"	No	"	thin shale lens
3	520.65			P	0°	sm	mt	"	"	"	
RUN 5	526 -	536									
1	526.7			P	0°	polished	mt	No	No	Un	Shale lens
2	531.85			P	5°	sm	"	"	"	"	
										"	
RUN 6	536 -	546									
1	538			S	15°	R	open	No	Calcite	Un	V. thin calcite flakes
2	539.7			S	15°	R	"	"	quartz	Un	
3	540			U	10°	R	mt	"	No	SW	fossils
4	540.35			U	5°	R	"	"	calc.	Un	
5	540.75			P	10°	silty R	"	"	"	"	shale
6	541			P	5°	R	open	"	qtz	"	very coarse surface
7	543			P	0°	R	mt	"	calc.	"	
8	543.85			U	0°	SR	Open	"	"	SW	
9	543.9			P	0°	SR	Open	"	"	"	

JOINT CLASSIFICATION LOG

DATE: Dec. 10, 92

ELEV. TOP OF HOLE ________ PROJECT NAME ________________ CORE BORING NO. CS-1

PAGE 3

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 7	546 – 556										
1	545.55			S	0°	R	mt	No	No	SW	
2	545.75										mB
3	547										mB
4	547.65			P	0°	SR	mt	No	No	SW	shale seam
5	547.75			P	10°	"	"	"	"	SW	
6	547.8			P	"	sm	"	"	"	Un	shale seam
7	548.45			U	"	SR	"	"	"	SW	
8	548.75			S	5°	"	"	"	"	SW	Shale seam
9	549			S	10°	R	open	"	calc.	W	
10	549.9			S	10°	R	"	"	No	W	
11	550.8			U	15°	R	mt	"	"	Un	
12	551.4			P	5°	SR	mt	"	"	W	calcite nudle
13	552										mB
14	552.45			S	15°	R	mt	No	No	SW	
15	553.3			S	15°	R	mt	"	"	"	
16	553.7			S	0°	Very R	Open	"	"	"	
17	553.95			U	0°	SR	mt	"	"	UN	
18	554.45										mB
Run 8	556 – 566										
1	556.05			U	0°	SR	mt	No	No	Un	Shale lens
2	557			U	"	"	"	"	"	SW	" "
3	558			U	"	"	"	"	"	"	" "

JOINT CLASSIFICATION LOG

DATE: Dec. 92

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-1

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
4	558.7			U	0°	SR	mt	No	No	SW	Shale lens
5	559			U	5°	Sm	"	"	"	UN	" " (2mm)
6	560.85			S	10°	R	"	"	Calc.	SW	" "
7	562.5			S	"	"	"	"	"	"	" "
8	563			S	0°	"	Open	"	"	"	
9	564.85			S	0°	"	mt	"	"	Un	calcite & qtz with vuggs
Run 9	566 -	574									
1	565.14			P	0°	SR	mt	No	No	Un	
2	565.5			U	5°	"	O	"	"	"	Shale lens 1" thick
3	565.6			U	0°	"	mt	"	"	SW	" " (2mm)
4	565.95			P	"	R	O	"	Calc.	"	
5	566.2			S	10°	"	O	"	No	"	
6	567			U	5°	"	mt	"	"	"	
7	567.7			S	0°	"	O	"	"	"	Shale lens
8	568.3			S	"	"	mt	"	"	"	
9	568.6			U	"	"	"	"	"	"	
10	569.35			U	"	"	"	"	"	"	
11	569.7			U	5°	"	"	"	"	"	Shale lens
12	570.3			P	0°	"	"	"	"	"	
13	571.4			U	10°	"	"	"	"	"	Shale lens
14	572.4			U	5°	"	"	"	"	"	
15	573.1			S	0°	"	"	"	"	"	
16	573.4			U	"	"	"	"	"	"	Shale lens

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ________ PROJECT NAME ________ CORE BORING NO. CS-1

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 10	574 –	584									
1	574.95			S	0°	R	T	No	No	Un	
2	576.3			U	"	SR	T	"	"	"	Joint @ Shale – L.S. interface
3	577.7			"	5°	"	mt	"	"	"	Shale lens
4	579.2			"	0°	"	"	"	"	"	" "
5	579.3			"	5°	"	"	"	"	"	" "
6	582.4			"	0°	"	"	"	"	"	thin shale lens
7	583.35			"	5°	"	"	"	"	"	quartz lens (3/4" thick)
8	583.6			P	0°	"	Open	"	calcite	SW	calcite film
Run 11	584 –	594									
1	584.2			P	0°	SR	mt	No	No	SW	
2	585.8			S	30°	R	"	"	"	Un	shale lens
3	586.2			S	45°	"	"	"	"	"	
4	587			P	55°	"	"	"	calcite	SW	shale & calcite
5	587 —	587.8		U	80°	"	"	"	"	Un	shale lens, vertical w/pyrite
6	588.4			S	30°	"	Open	"	Pyrite	SW	Broken – crushed rock & pyrite
7	589			U	10°	"	mt	"	No	Un	shale lens
8	589.4			S	5°	R	O	"	"	"	
9	590			S	15°	"	O	"	Pyrite	"	
10	590.6			U	10°	"	mt	"	No	"	
11	591.5										MB
12	592			S	10°	"	"	"	"	"	
13	592.7			S	10°	"	Open	"	"	SW	
14	592.95			U	0°	SR	"	"	"	"	calcite film

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ________ PROJECT NAME ________ CORE BORING NO. CS-1

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
15	593.05			S	40°	R	open	No	No	SW	
16	593.3			S	5°	"	"	"	Pyrite	"	Pyrite residue & calcite
										"	
Run 12	594 - 604										
1	594.5			P	45°	R	open	No	pyrite	Un	qtz, shale & trace of pyrite
2	594.95			P	5°	"	"	"	No	"	
3	595.2			U	10°	"	mt	"	"	"	
4	595.5			S	45°	"	O	"	"	SW	crushed rock filling
5	596.1			P	0°	"	mt	"	"	No	
6	596.4			P	15°	"	mt	"	qtz	"	
7	596.7			P	0°	"	O	"	No	SW	
8	596.8			P	15°	"	O	"	"	UN	
9	597.15			P	"	"	mt	"	"	"	
10	598.3			P	0°	SR	O	"	"	SW	calcite
11	598.9			P	"	"	mt	"	"	Un	
12	599.6			S	30°	"	"	"	"	SW	shale lens w/ calcite
13	600.1			U	15°	R	"	"	"	SW	
14	600.9			U	30°	SR	"	"	"	Un	shale lens
15	601.7			P	10°	"	"	"	"	Un	
16	602.45			S	15°	"	"	"	"	Un	shale lens (v. thin)
17	603.3			P	10°	"	"	"	"	Un	Very thin shale lens

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ________ PROJECT NAME ________ CORE BORING NO. CS-1

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 13	604 -	609									
1	605.55			U	0°	Sm	mt	No	No	Un	2mm shale lens
2	605.65			P	"	"	O	"	"	"	crushed shale
3	605.75			P	10°	SR	"	"	"	"	" "
4	606.4			U	15°	"	mt	"	"	"	shale lens
5	607.3			U	"	R	"	"	"	"	" "
6	607.45			U	"	"	"	"	"	"	" "
7	608			S	5°	"	O	"	"	"	" "
Run 14	609 -	615.5									
1	609.7			S	15°	R	mt	No	No	Un	
2	611.2			S	"	"	"	"	"	"	
3	611.8			P	0°	Sm	O	"	"	"	
4	611.9			"	"	"	"	"	"	"	
5	612.45			"	"	SR	mt	"	"	SW	
6	612.95			"	"	"	"	"	"	"	
7	613.3			"	"	"	O	"	"	"	
8	613.75			"	5°	"	mt	"	"	"	
9	614.2			S	40°	"	O	"	"	"	
10	614.3			P	0°	"	"	"	"	"	
11	614.55			"	"	"	"	"	"	"	
12	614.7			"	"	"	"	"	"	"	
13	614.8			U	5°	"	mt	"	"	UN	mB ?
14	614.9			P	"	"	"	"	"	"	
15	615.25			P	"	"	O	"	"	SW	

JOINT CLASSIFICATION LOG

DATE: Dec. 92

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS - 1

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	615.6			U	20°	SR	open	No	No	SW	
Run 15	615.5 -	625.5									
1	616.05			U	15°	SR	O	No	No	Un	4mm shale lens
2	616.7			P	"	Sm	mt	"	"	SW	
3	617.1			P	0°	SR	"	"	"	SW	
4	618			S	"	"	O	"	"	UN	Interface of L.S. & shale
5	619.25			P	"	Sm	mt	"	"	"	
6	619.8			P	"	"	"	"	"	"	
7	621.05			U	"	"	"	"	"	"	
8	621.3			P	"	"	"	"	"	"	
9	621.75			P	"	"	"	"	"	"	
Run 16	625.5 -	630.5									
1	625.5			P	5°	SR	mt	No	No	SW	
2	626.4			P	0°	"	"	"	"	Un	
3	628.2			S	5°	R	"	"	"	"	2mm shale lens
4	629.4			P	"	SR	"	"	"	SW	
5	629.8			P	15°	"	"	"	"	"	
	BOH @ 630.5										

JOINT CLASSIFICATION LOG

DATE: Dec. 2, 92

ELEV. TOP OF HOLE ________ PROJECT NAME UTP CORE BORING NO. CS-2 PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
Run 1	500	505.4									
	500.8			P	0°	pl	mt	No	No	un	* un: unweathered
	501.3			"	"	"	"	"	"	"	
	502.1			"	"	"	"	"	"	"	Top wall gray shale
	502.75			"	"	"	"	"	"	"	" " " "
	503.3			"	"	"	"	"	"	"	
	503.85			"	"	"	"	"	"	"	
	504.85			"	"	"	"	"	"	"	
Run 2	505.4	515.5									
	505.55			P	0°	sm	O	No	No	un	
	505.9			"	"	"	"	"	"	SW	
	506.25			"	"	pl	"	"	"	un	
	506.6			"	"	sm	"	"	"	"	
	507			"	"	pl	"	"	"	"	
	507.3			"	"	pl	mt	"	"	"	
	507.9			"	"	sm	"	"	"	"	
	~~[illegible]~~										
	508.55	mB									mB
	509.25			"	"	pl	mt	"	"	"	
	510.6			"	"	pl	"	"	"	"	
	511.35			"	"	pi	"	"	"	"	
	511.0	514.2		U	90°	sR	"	"	Calc.	"	vertical jt. healed @
	511.9			S	0°	sm	O	"	No	"	511–511.9 w/calcite cementing
	512.1			P	"	sR	mt	"	calc.	SW	then broken w/calc. residue

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-2

PAGE 2

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	512.65			S	15°	Sm	O	No	No	Un	Broken rock
	513.2			P	0°	pl	mt	"	"	"	
	513.4			"	"	Sm	"	"	"	"	
	513.5			"	"	"	"	"	"	"	
	514.4			"	"	"	"	"	"	"	
	515.15			"	"	"	"	"	"	SW	filled w/coarse sand size
	515.45			"	"	"	"	"	"	un	broken rock
Run 3	515.5 -	525.5									
	516.6			P	0°	Sm	mt	No	pyrite	Un	
	517.65			P	"	"	"	"	No	"	
	518.3			U	5°	"	"	"	"	"	
	519.3			P	0°	SR	"	"	pyrite	SW	Contact w/ L.S
	520.5			U	5°	"	"	"	pyrite	"	
	521.3			U	15°	R	"	"	No	"	
	522.2			S	"	"	"	yes	pyrite	"	
	522.85			S	0°	"	"	"	"	"	
	523.6			U	"	"	"	No	No	"	
	524.35			S	15°	"	"	"	pyrite	Un	v. thin shale vein
Run 4	525.5 -	535.3									
	526.1			U	0°	R	mt	No	No	SW	Shale seam
	526.9			P	"	"	"	"	"	un	
	527.45			"	10°	Sm	"	"	"	"	
	527.55			U	"	"	"	"	"	"	Shale seam

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-2 PAGE 3

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 5	535.8	545.8									
	537.3			P	0°	Sm	mt	No	No	un	mB?
	544.15			U	5°	"	"	"	"	"	
	544.65			U	"	SR	"	"	"	"	
	545.4			S	25°	R	O	"	qtz.	sw	Vug.
Run 6	545.8	556									
	546.5			U	0°	SR	mt	No	No	Un	
	547			S	15°	R	O	"	"	"	
	547.3			U	10°	SR	mt	"	"	"	
	547.35			U	"	"	"	"	"	"	
	547.85			U	"	"	"	"	"	"	
	548.55			P	"	"	O	"	"	"	
	548.75			U	"	"	O	"	"	sw	
	548.9			U	0°	R	O	"	"	w	Very vuggy - eroded
	549.6			P	5°	"	mt	"	"	sw	
	550.1			U	10°	"	O	"	qtz.	w	fossils
	550.7			U	"	"	O	"	No	w	
	551			S	15°	"	O	"	"	sw	
	551.1			U	0°	"	"	"	"	"	
	551.7			"	"	"	"	"	"	un	
	552.25			"	"	"	mt	"	"	sw	
	552.55			"	5°	"	"	"	"	un	
	552.7			"	10°	SR	"	"	Calc	sw	
	553			S	"	R	"	"	"	un	

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ________ PROJECT NAME ____________ CORE BORING NO. CS-2

PAGE 4

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
	553.4			S	20°	R	O	No	No	W	eroded
	554			U	10°	"	mt	"	"	un	
	554.85			U	15°	"	"	"	"	"	
	554.9			U	"	"	"	"	"	"	
	555.3			P	0°	SR	"	"	calc.	SW	
	555.85			S	15°	R	"	"	No	un	
Run 7	556 - 566										
	556.4			S	0°	R	mt	No	No	Un	
	556.9			U	"	sm	"	"	"	"	Shale seam
	558.8			U	"	"	"	"	"	"	
	559.5			U	15°	"	"	"	"	"	
	560.1			U	0°	SR	"	"	"	W	
	560.55			S	15°	R	"	"	"	W	
	561.55			U	0°	"	O	"	"	SW	
	561.8			U	15°	"	mt	"	"	"	
	562.25			U	0°	SR	"	"	"	"	
	562.9			S	15°	R	"	"	"	"	Vuggy bottom wall
	563.35			S	"	"	"	"	"	"	
	563.5			U	"	"	"	"	"	"	
	564.15			U	0°	SR	"	"	"	Un	
	564.6			P	"	"	O	"	calc.	SW	
	564.8			S	"	R	mt	"	"	"	
	565.15			P	5°	sm	"	"	"	"	Shale seam
	565.7			U	"	"	"	"	"	Un	

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ____________ PROJECT NAME ____________________ CORE BORING NO. CS-2

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JOINT NO.	DEPTH	ELEV.	JOINT PER. FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 3	566 –	576									
	566.34			U	15°	sm	mt	No	No	Un	2 mm thick shale seam
	566.5			"	"	"	"	"	"	"	1 mm " " "
	567.5			"	10°	"	"	"	"	"	" " " "
	567.9			"	"	SR	"	"	"	SW	
	568.4			"	15°	R	O	"	"	"	shale seam
	568.85			"	10°	"	"	"	qtz	"	
	569.1			"	0°	"	"	"	calc.	W	eroded & broken to flakes
	569.4			S	25°	"	"	"	No	"	eroded
	569.9			S	10°	"	mt	"	"	SW	
	569.9 –	570.15		P	90°	SR	"	"	calc.	"	
	570.55			U	10°	sm	"	"	No	Un	4 mm shale seam
	570.8			"	"	SR	"	"	"	"	
	571.35			"	0°	"	"	"	"	"	
	571.8			"	5°	"	"	"	"	SW	
	572.5			S	0°	R	"	"	"	"	
	573			P	"	"	"	"	"	"	
	573.5			U	5°	"	O	"	calc.	W	
	574			S	15°	"	mt	"	No	Un	
	574.6			U	5°	SR	O	"	"	"	
Run 9	576 –	586.2									
	576.45			P	0°	sm	mt	No	No	Un	} shale bed
	576.55			"	"	"	"	"	"	SW	
	576.75			S	10°	R	"	"	"	"	

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-2

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JOINT NO.	DEPTH	ELEX.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	577.25			P	10°	SR	mt	No	No	SW	
	577.65			"	0°	"	"	"	"	"	
	578.1			S	20°	"	"	"	"	"	
	578.3			"	15°	"	"	"	"	Un	
	578.6			U	10°	"	"	"	"	SW	
	578.9			S	5°	R	"	"	"	"	
	579.4			U	0°	SR	O	"	"	"	
	579.8			"	20°	"	O	"	"	"	
	580.2			"	10°	"	mt	"	"	"	
	580.6			"	"	"	"	"	"	"	
	580.7			S	0°	R	"	"	"	"	
	580.85			U	"	SR	"	"	"	"	
	590.85			P	"	"	"	"	"	"	
	591.4			"	10°	"	"	"	"	"	
	591.8			U	20°	Sm	"	"	"	"	
	592.8			"	0°	SR	"	"	"	Un	
	593.45			"	10°	Sm	"	"	"	SW	
	593.9			"	"	"	"	"	"	Un	shale seam
	594.3			"	0°	"	"	"	"	SW	" "
Run 10	586.2 - 596.4										
	587.3			S	20°	R	mt	No	No	Un	
	587.6			U	10°	Sm	"	"	"	"	
	588.3			P	20°	"	"	"	"	"	4 mm shale seam
	589.2			"	"	"	"	"	"	"	

JOINT CLASSIFICATION LOG

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ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-2

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JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	590.35			U	15°	R	mt	No	No	Un	} ~~Shale Lens~~
	590.9			S	"	"	"	"	"	"	
	593.7			"	"	"	"	"	"	"	
	594.4			U	5°	SR	"	"	"	SW	
	595.3			"	10°	"	"	"	"	Un	shale lens
	596.05			"	40°	"	"	"	"	SW	
Run 11	596.4	606.3									
	597.15			U	15°	SR	mt	No	No	Un	2 mm shale vein
	598.3			S	"	R	"	"	"	"	
	600.3			"	0°	"	O	"	"	"	shale vein
	600.7			"	"	"	mt	"	"	"	" "
	602			U	"	SR	"	"	"	"	
	602.3			S	"	R	"	"	"	"	shale vein
	603.45			U	15°	"	"	"	"	SW	
	603.35			"	5°	SR	"	"	"	"	
	604.3			P	0°	R	O	"	qtz.	SW	
	604.95			S	10°	"	"	"	No	Un	
	605.4			P	0°	SR	"	"	"	W	
	605.5			S	15°	"	mt	"	"	Un	
	605.7			"	"	R	O	"	"	W	Vug
	606			"	"	"	O	"	"	W	Vug

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-2

PAGE 8

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 12	606.3	616.3									
	606.6			U	15°	SR	mt	No	qtz.	sw	
	607			P	"	"	"	"	"	"	
	607.45			"	0°	"	"	"	"	"	
	608			S	90°	"	"	"	"	Un	
	608.15			P	0°	sm	mt	"	No	"	
	608.25			U	"	SR	"	"	qtz	"	
	608.6			P	15°	"	"	"	"	sw	
	609			S	"	R	"	"	"	"	Vug
	609.45			S	0°	R	"	"	No	"	Shale seam (1mm)
	609.65	610		P	90°	SR	"	"	"	Un	
	610.2			U	15°	"	"	"	"	"	
	610.8			"	0°	"	"	"	"	"	Shale seam (1mm)
	611.2			S	15°	R	"	"	"	"	
	611.4			U	0°	sm	"	"	"	"	
	611.55			P	15°	SR	"	"	"	"	
	612.3			"	=	"	"	"	"	"	
	612.5			U	15°	"	"	"	"	"	Shale seam (2mm)
	612.8			P	0°	"	"	"	"	"	
	613.4			"	0°	"	O	"	"	"	
	613.35			"	5°	sm	mt	"	"	"	Shale seam (1mm)
	614.2			U	15°	SR	"	"	"	"	" " "
	614.9			"	5°	sm	"	"	"	"	" " "

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-2 PAGE 9

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 13	616.3 – 626.3										
	617.45			U	45°	pl sm	mt	No	No	Un	2 mm shale vein
	618.1			"	15°	"	"	"	"	"	6 mm " "
	620.4			"	40°	SR	"	"	"	"	
	621.2			S	"	R	"	"	"	"	shale vein
	621.5			S	"	"	"	"	"	"	
	621.9			P	0°	SR	"	yes	"	"	green colorization
	622.35+			"	5°	"	"	"	"	"	
	622.7			S	"	R	"	"	"	"	
	623.1			U	45°	SR	"	"	"	"	
	624			"	30°	sm	"	"	"	"	shale seam
	624.6			S	"	SR	"	"	"	"	
	624.75+			U	10°	"	O	"	"	"	shale seam
	625.7			P	0°	"	mt	"	"	SW	
Run 14	626.3 – 636.3										
	626.15+			P	0°	SR	O	No	No	Un	
	626.45+			U	15°	"	mt	"	"	"	
	627.4			P	5°	"	"	"	"	"	
	627.85+			"	0°	"	"	"	"	"	
	627.75+			"	0°	sm	"	"	"	"	shale seam
Run 15	636.3 – 642.4										
	639.1			P	0°	sm	mt	No	No	un	
	640.9			S	25°	R	"	"	"	"	
	641.7			P	15°	SR	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: Dec. 29, 92

ELEV. TOP OF HOLE ____________ PROJECT NAME UTP CORE BORING NO. CS-3

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 1	499.3 –	505									
	500.05			P	0	pl	mt	No	No	UN	
	500.4			P	0	pl	"	"	"	"	
	500.63			P	0	sm	"	"	"	"	
	500.9			"	"	pl	"	"	"	"	
	501.18			"	"	"	"	"	"	"	
	501.43			"	"	"	"	"	"	"	
	501.7			"	"	"	"	"	"	"	
	502			"	"	"	"	"	"	"	
	502.2			"	"	"	"	"	"	"	
	502.53			"	"	"	"	"	"	"	
	503.15			"	"	"	"	"	"	"	
	504.75			"	"	"	"	"	"	"	
	504.05			"	"	"	"	"	"	"	
	504.1			"	"	"	"	"	"	"	
	504.3			"	"	"	"	"	pyrite	SW	
	504.7			P	0	SR	"	"	calcite	"	L.S.
	505			P	0	pl	O	"	"	SW	
Run 2	505 –	514									
	505.35			P	0	pl	OP	No	No	UN	
	506.07			P	0	"	OP	"	"	"	
	506.5			"	"	"	"	"	"	"	
	507.2			"	"	"	"	"	"	"	
	507.7			"	"	"	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: Dec 29-30-1992

ELEV. TOP OF HOLE ________ PROJECT NAME ________ CORE BORING NO. CS-3

PAGE 2

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	508.55			P	0°	Pl	OP	No	No	UN	
	509.4			"	"	"	"	"	"	"	
	510.45			"	"	"	"	"	"	"	
	510.6			P	0°	Pl	mt	No	No	UN	mB ?
	511.15			P	0°	Pl	mt	No	No	UN	
	511.2			P	0°	Pl	OP	No	No	UN	
	511.95			"	"	"	mt	"	"	"	
	513.55			"	"	"	mt	"	"	"	
n 3	514	524.8									
	514			P	0°	sm	mt	No	No	UN	
	514.05			"	"	"	OP	"	"	"	
	515.5			P	0°	"	mt	"	"	"	
	517.05			"	"	"	OP	"	"	"	
	517.52			P	5°	SR	OP	No	Pyrite	SW	
	517.75			U	15°	SR	mt	No	No	SW	
	518.4			P	0°	SR	OP	No	No	SW	
	518.65			U	15°	SR	OP	No	No	"	
	519.3			P	5°	SR	OP	No	No	"	
	519.55			P	0°	"	mt	"	"	SW	
	519.75			U	40°	"	"	"	"	"	
	520.55			U	5°	sm	"	yes	"	SW	Green colored
	521.3			S	0°	R	"	"	"	"	
	521.67			P	"	SR	"	"	"	Un	
	521.72	521.82									crushed rock

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-3

PAGE 3

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	521.9			P	0°	sm	O	No	No	SW	
	522.45			S	30°	R	mt	"	"	"	
	523.6			U	5°	SR	O	"	"	W	v. thin shale vein
	523.75			P	0°	"	O	"	"	"	
Run 4	524 —	534.3									
	524.6			P	0°	SR	O	No	No	Un	
	525.4			U	"	sm	mt	"	"	SW	
	525.6			P	"	"	"	"	"	Un	
	526.2			P	"	"	"	"	"	"	Shale vein
	527.3			P	"	"	"	"	Pyrite	"	
	529.85			P	"	"	"	"	No	"	
Run 5	534.3 —	544.3									
	536.32			P	0°	sm	mt	No	No	Un	
	538.2			U	"	"	"	"	"	"	
Run 6											

JOINT CLASSIFICATION LOG

ELEV. TOP OF HOLE ________ PROJECT NAME ________ DATE: ________

CORE BORING NO. CS-3

PAGE 4

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 6	544.3 -	554.5									
	544.5			P	10°	R	mt	No	No	Un	
	544.9			U	0°	"	O	"	"	SW	Vugged
	545.2			U	"	"	"	"	"	"	
	545.3			U	"	SR	"	"	"	"	next 0.1 broken rounded rock.
	545.4			S	20°	R	"	"	NO	"	Vugged
	545.9			U	10°	SR	mt	"	"	Un	
	546.2			U	"	"	O	"	"	Un	
	546.63			P	0°	"	O	"	"		Vugged
	546.9			U	15°	"	mt	No	"	Un	1 mm shale vein
	547.12			U	0°	"	O	"	"	"	2 mm " "
	547.6			U	"	R	O	"	"	SW	Vugged
	543.15			P	15°	"	mt	"	"	Un	fossils
	549.15			U	10°	"	"	"	"	SW	
	549.5			P	0°	SR	"	No	"	"	
	550.05			U	30°	SR	"	"	"	Un	
	550.3			U	"	"	O	"	Yes	SW	Green coloring / shale
	550.75										mB
	551.1			P	0°	R	mt	No	No	Un	Very Porous (Vugged)
	551.7										mB
	552.35			P	0°	Sm	mt	No	No	Un	
	552.65			P	"	"	"	"	"	"	
	553.17			P	"	"	"	"	"	"	
	553.45			U	"	SR	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-3

PAGE 5

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
	553.65			P	15°	SR	mt	No	No	Un	
	553.85			"	5°	Sm	"	"	"	"	
	553.95			"	0°	SR	"	"	"	"	
	554.1			"	"	"	"	"	"	"	
Run 7	554.6 - 564.4										
	554.75			U	0°	SR	mt	No	No	SW	shale vein
	555.25			U	"	Sm	O	"	"	"	
	555.45			U	"	SR	O	"	"	"	
	555.7			P	"	Sm	O	"	"	"	
	556.1			U	15°	"	mt	"	"	"	
	556.33			S	0°	SR	O	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-3

PAGE 6

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
	556.5			S	15°	SR	O	No	No	Un	Shale vein
	557			U	0°	sm	mt	"	"	"	" "
	557.6			P	"	"	"	"	"	"	" "
	558.8			U	"	"	"	"	"	"	" "
	559.3			P	"	"	O	"	"	"	" "
	559.35			P	"	"	O	"	"	Un	" "
	559.65			S	10°	R	mt	"	"	W	
	560.1			S	20°	"	"	"	"	"	
	560.55			S	10°	"	"	No	"	W	
	561			S	"	SR	"	"	No	SW	
	561.4			S	25°	R	"	"	crystll.	"	
	561.9			S	15°	"	mt	"	No	"	
	561.95			S	25°	"	O	"	qtz.	W	crystals / (vugged)
	562.3			S	0°	R	O	"	qtz.	"	"
	562.7			S	30°	"	mt	"	NO	"	
	563.15			U	10°	"	O	"	"	"	
	563.4			P	0°	"	mt	"	"	SW	
	563.7			U	25°	SR	"	"	"	"	
	564.1			U	15°	R	"	No	No	SW	

JOINT CLASSIFICATION LOG

DATE: ____

ELEV. TOP OF HOLE ____ PROJECT NAME ____ CCRE BORING NO. CS-3

PAGE 7

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 8	564.9 -	574									
	564.65			P	25°	R	OP	No	Pyrite		
	564.8			S	0°	sm	OP	"	No	mod. W	1 mm shale vein
	564.95			U	"	SR	mt	"	No	"	" " "
	565.7			S	10°	"	"	"	pyrite	SW	trace of pyrite (Vugged)
	566.1			U	20°	sm	"	"	No	"	4 mm shale vein
	567.15			"	"	SR	"	"	"	Un	
	567.75			"	0°	"	"	"	"	SW	
	567.85			"	"	"	"	"	"	Un	
	568.2			"	15°	sm	"	"	"	mW	
	568.62			P	"	SR	"	"	"	SW	
	569.02			U	"	"	mt	"	"	"	
	569.47			P	5°	sm	"	"	"	"	
	569.55			S	10°	R	"	"	"	"	
	569.9			S	"	R	"	"	"	W	Vugged walls
	570.6			U	"	SR	"	"	"	"	
	571			U	5°	"	"	"	"	"	Vugged walls
	571.65			S	45°	R	"	"	"	"	2 mm shale vein
	572.15			U	10°	"	"	"	"	"	
	572.65			U	30°	"	"	"	"	"	
	573.15			S	"	VR	mt	"	"	SW	some shale

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-3

PAGE 8

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 9	573.75	– 582.1									
	574			P	0°	SR	mt	No	No	SW	Left wall L.S., Right is shale
	574.37			P	"	"	"	"	"	Un	
	575.4			U	"	"	"	"	"	"	
	576			S	15°	R	O	"	"	SW	left wall shale, Right L.S.
	576.35			P	5°	SR	mt	"	"	"	
	577.2			P	15°	"	"	"	"	"	
	577.72			U	25°	"	"	"	"	"	
	578.1			U	15°	"	O	"	"	W	Some shale
	578.4			P	0°	"	O	"	"	"	
	578.55			U	0°	R	O	"	"	"	
	579.05			U	10°	SR	mt	"	"	"	
	579.5			S	20°	R	"	"	"	"	
	579.9			S	5°	"	"	"	"	"	
	580.05			S	5°	"	"	"	"	SW	2 mm shale vein
	580.5			U	5°	"	"	"	"	"	
	580.8			P	0°	"	"	"	"	"	
	581.35			U	10°	"	"	"	"	"	
	581.5			U	30°	"	"	"	"	"	
	581.85			U	0°	"	O	"	"	Un	quartz lens Jointed
Run 10	582.1	– 583.9									at its middle
	582.4			U	10°	SR	mt	No	No	Un	
	582.95			U	15°	"	"	"	"	"	
	583.55			S	"	R	"	"	"	SW	
	583.8			U	20°	"	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______　　PROJECT NAME ______　　CORE BORING NO. CS-3

PAGE 9

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 11	593.9	– 594									
	584.45			U	0°	sm	o	No	No	SW	
	586.5			U	20°	"	mt			"	2 mm shale vein
	586.75			"	"	"	"				
	588.25			"	0°	"	"			Un	2 mm shale vein
	589.7			"	10°	"	"			"	1/2" thick shale lens
	591.85			S	40°	R	"			"	2 mm shale vein
	592.2			U	0°	"	"			W	
	592.7			U	10°	"	"			Un	" " "
Run 12	594	– 604.2									
	594.6			S	5°	R	mt	No	No	Un	
	595.75			P	15°	sm	"	"	"	Un	3 mm thick shale vein
	596.85			U	"	sR	"	"	"	"	4 mm " " "
	597.3			S	0°	R	"	"	"	"	
	597.65			U	"	sR	"	"	"	SW	
	598			S	30°	R	"	"	"	Un	
	598.55			P	15°	sm	"	"	"	"	
	599			U	0°	R	o	"	"	"	shale lens w/ fine fragments
	599.65			U	30°	sm	mt	"	"	"	2 mm thick shale vein
								"	"	"	
	600.22			S	20°	R	mt	"	"	"	1 mm " " "
	600.4			U	15°	R	"	"	"	"	
	601	– 601.5		U	90°	R	mt	No	No	Un	
	601.5			S	0°	VR	"	"	"	SW	

JOINT CLASSIFICATION LOG

DATE: ____

ELEV. TOP OF HOLE ____ PROJECT NAME ____ CORE BORING NO. CS-3

PAGE 10

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
	601.85			S	40°	R	mt	No	No	SW	
	602.45			S	0°	"	O	"	"	"	
	602.55 -	602.6						"	"		Crushed Rock
	602.6			S	25°	R	O	"	"	W	
	602.7			P	45°	"	O	"	"	Un	
	603.4			P	"	"	mt	"	"	SW	
	603.5			S	15°	"	O	"	"	"	
	603.9			S	40°	"	O	"	qtz	"	eroded (Vug)
R.n 13	604.2 -	614.3									
	605.1			U	40°	R	mt	No	No	Un	eroded
	605.6			P	30°	"	"			"	
	606.6			P	0°	"	"			"	
	607.05			U	"	"	"			"	
	607.3			P	"	"	"			"	
	608.15			U	"	"	"			"	
	608.7			P	15°	"	"			"	
	609.6			U	0°	"	"			"	
	610.25			S	"	SR	O			"	
	610.9			U	"	"	mt			"	
	611.15			P	15°	SR	O			"	
	612.05			U	"	R	mt			"	
	612.35			P	5°	R	"			"	
	613			S	0°	R	mt	No	No	Un	
	613.85			S	0°	VR	"	"	"	"	2 mm shale vein

JOINT CLASSIFICATION LOG

DATE:

ELEV. TOP OF HOLE

PROJECT NAME

CORE BORING NO. CS-3

PAGE 11

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
Run 14	614.3	- 616									
	614.3	- 614.6									Broken by drilling
	614.6			P	0°	R	O	No	No	Un	
	614.8			P	20°	SR	mt	"	"	"	shale lens
	615.05										mB
	615.5			P	5°	sm	O	"	"	"	Shale lens separated on
											both faces
	615.55			P	25°	sm	O	No	No	Un	
	615.7			U	35°	pl	"	"	"	"	
	615.75			"	25°	sm	"	"	"	"	
15	616	- 626.1									
	616.55			P	5°	sm	mt	No	No	Un	2mm shale seam
	618.9			U	25°	SR	"	"	"	"	" " "
	620.55			"	20°	sm	"	"	"	"	" " "
	622.65			"	15°	SR	"	"	"	"	
	624.5			P	5°	"	"	"	"	"	
	625.3			U	15°	sm	"	"	"	"	2mm shale seam
Run 16	626.1	- 636.3									
	629.2			P	0°	sm	mt	No	No	Un	
	630.72			"	"	"	"	"	"	"	
	631.42			"	5°	"	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ____

ELEV. TOP OF HOLE ____ PROJECT NAME ____ CORE BORING NO. CS-3

PAGE 12

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 17	636.3	-639.45									
	638.1			S	0°	R	t-mt	No	No	Un	shale lens

JOINT CLASSIFICATION LOG

DATE: Dec. 15, 92

ELEV. TOP OF HOLE ______ PROJECT NAME UTP

CORE BORING NO. CS-4

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 1	499.2 –	505.3									
	499.5 –	499.6									clay bed
	499.7 –	499.9									clay bed
1	499.4			P	0°	Sm	open	No	No	SW	
2	500			"	15°	"	"	"	"	SW	clay filling w/ fine crushed rock
3	500.4			"	0°	"	mt	"	"	Un	mB ?
4	500.95			"	"	"	"	"	"	"	mB ?
5	501.4			"	"	"	"	"	"	"	mB ?
6	502.25			"	"	"	"	"	"	"	
7	503.05			"	"	"	"	"	"	"	
8	503.4			"	"	"	"	"	"	"	
9	503.7			"	"	"	"	"	"	"	
10	503.85			"	0°	"		"	"	SW	
11	504.6			"	0°	"		"	"	UN	
Run 2	505.3 –	515.3									
1	505.33			U	0°	Sm	Open	No	No	Un	
2	505.35			U	"	"	O	"	"	"	
3	505.9			P	"	polished	mt	"	"	"	
4	506.25			P	"	f SW	Open	"	"	"	
5	506.3			"	"	polished	mt	"	"	"	
6	506.7			"	"	SR	Open	"	"	SW	Pyrite lens at one side wall
7	506.85			"	"	Sm	mt	"	"	"	
8	507.3			"	"	"	open	"	"	"	
9	507.5			"	"	"	Open	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-4

PAGE 2

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
10	509.35			P	5°	Sm	mt	No	No	Un	
11	510.3			U	15°	"	"	"	"	"	
12	510.8			P	0°	"	O	"	"	"	
13	511.2			U	"	SR	O	"	"	"	
14	512.4			P	"	Sm	O	"	"	"	
15	512.7			P	"	"	O	"	"	"	Pyrite lens at top wall
	513.4										mB
16	513.9			U	0°	sm	O	"	"	"	
	514										mB
17	514.1			P	0°	sm	O	"	"	"	
	514.85										mB
RUN 3	515.3 -	525.3									
1	515.3			P	0°	Pl	mt	No	No	Un	
2	516.2			U	10°	sm	O	"	"	"	Trace of pyrite
3	517.5			P	0°	Pl	mt	"	"	"	
4	518.2			"	"	sm	mt	"	"	"	" " "
5	518.9			U	"	"	O	"	"	"	
6	519.8			P	"	"	mt	"	"	"	
											L.S. Stratum starts at
											520.2 with .05 pyrite
											lens between Shale &
											L.S.
7	520.85			P	5°	SR	mt	No	No	SW	
8	521.3			S	"	R	"	"	"	"	Shale Seam

JOINT CLASSIFICATION LOG

ELEV. TOP OF HOLE ________ PROJECT NAME ________ DATE: ________

CORE BORING NO. CS-4

PAGE 3

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
9	523.3			S	25°	R	O	Yes	pyrite	sw	green coloring
10	524.1			"	0°	"	O	NO	NO	"	shale lens / seam
Run 4	525.3 – 535.3										
1	525.25			U	0°	SR	mt	No	No	sw	
2	526.15			S	"	R	"	"	"	Un	thin shale lens
3	526.6			P	15°	sm	"	"	"	"	" " .
4	527.8			P	0°	SR	O	"	"	"	changing from L.S. to
											shaly L.S. w/1' lens of shale (gr.
5	530.55			P	0°	sR	mt	"	"	"	
Run 5	535.3 – 545.5										
1	539.15			P	0°	pl	mt	No	No	Un	
2	544.1			"	"	sm	"	"	"	"	
3	544.45			"	"	"	"	"	"	sw	
Run 6	545.5 – 555.7										
1	547			U	30°	SR	mt	No	No	Un	shale seam
2	548.6			U	15°	"	O	"	"	"	
3	549.4			U	"	"	mt	"	"	"	
4	550			S	0°	R	O	No	qtz.	"	Eroded w/ qtz. crystals
5	550.5			U	30°	SR	mt	"	No	Un	
6	551.2			U	15°	"	"	"	calcite	sw	calcite film
7	551.3			U	"	"	O	"	"	sw	" "
8	551.65			P	5°	"	O	"	No	sw	

JOINT CLASSIFICATION LOG

DATE: ____

ELEV. TOP OF HOLE ____ PROJECT NAME ____ CORE BORING NO. CS-4

PAGE 4

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
9	551.75			P	0°	SR	O	No	No	SW	
10	552.4			S	30°	R	"	"	"	Un	
11	552.9			S	15°	R	"	"	"	"	
12	553.5			P	0°	SR	"	"	"	"	
13	553.7			U	15°	"	"	"	"	"	shale lens
14	554			S	"	R	"	"	"	SW	
15	554.4			U	5°	SR	"	"	"	Un	
16	555			U	15°	"	"	"	"	"	
17	555.3			P	5°	"	"	"	"	"	
R.n 7	555.7 – 565.8										
1	555.75			P	0°	SR	O	No	No	Un	
2	555.8			P	"	"	O	"	"	"	
3	556.9			P	5°	"	mt	"	"	"	
4	557			P	0°	"	O	"	"	"	
5	557.4			U	5°	sm	mt	"	"	"	shale seam
6	558.3			S	"	R	"	"	"	"	v. thin shale seam
7	558.6			S	15°	"	"	"	"	"	" " " "
8	560.85			U	0°	sm	"	"	"	"	shale seam
9	561.6			U	15°	"	"	"	"	"	" "
10	561.95			U	5°	"	O	"	"	"	shale lens .5" thick
11	562			U	"	"	O	"	"	"	
12	562.7			S	"	R	O	"	"	SW	
13	562.4			S	15°	R	t	"	"	SW	
14	564.05			S	"	R	mt	"	calcite	SW	

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-4

PAGE 5

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
15	565.2			P	15°	SR	mt	No	No	SW	Shale seam
Run 8	565.8 – 576										
1	566.35			U	0°	R	mt	No	No	Un	Shale seam
2	566.8			U	"	SR	mt	"	"	"	" "
3	567.45			P	"	"	"	"	"	SW	
4	568.7			U	"	SM	"	"	"	"	" "
5	570.35			S	40°	R	"	"	"	Un	" "
6	572.15			U	30°	SR	"	"	"	SW	
7	572.4			U	0°	"	"	"	"	UN	" "
8	573			U	"	"	"	"	"	"	
9	573.45			S	"	R	"	"	"	"	
10	574.75			U	"	"	"	"	"	"	
11	575.5			U	5°	"	"	"	"	SW	Shale seam
Run 9	576 – 586										
1	576.15			P	0°	SR	mt	No	No	SW	
2	576.5			P	"	"	"	"	"	"	Shale lens at bottom
3	578.7			U	"	"	O	"	"	Un	Shale lens at top & bott.
4	578.75			U	15°	"	"	"	"	SW	
5	580.1			P	0°	"	"	"	"	"	
6	580.9			S	15°	R	mt	"	"	Un	Shale seam
7	581.3			U	5°	SR	O	"	"	"	
8	582.6			S	"	R	mt	"	"	"	" "
9	582.85			S	"	"	"	"	"	"	" "

JOINT CLASSIFICATION LOG

DATE: ____________

ELEV. TOP OF HOLE ____________ PROJECT NAME ____________ CORE BORING NO. CS-4

PAGE 6

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
10	584.4			S	5°	SR	mt	No	No	un	Shale seam
11	585.4			"	0°	R	"	"	"	"	" "
Run 10	586 – 596.2										
1	588.75			U	5°	Sm	mt	No	No	Un	3 mm shale lens
2	589			U	"	"	"	"	"	"	" " "
3	590.3			P	0°	"	"	"	"	"	shale lens
4	591.3			U	"	R	"	"	"	"	" " (1 mm)
5	591.8			S	"	"	"	"	"	SW	
6	593.85			U	"	Sm	"	"	"	"	" " "
	596			U	"	SR	"	"	"	"	" " "
Run 11	596.2 – 606.4										
	597.6			U	0°	SR	mt	No	No	un	2 mm shale lens
	598.65			"	"	"	"	"	"	"	" " "
	601.2			S	10°	R	"	"	"	"	" " "
	602.35			U	15°	"	"	"	"	"	" " "
	603.55			U	10°	"	"	"	"	SW	
	604.15			S	0°	"	O	"	qtz.	SW	Vuggy w/ quartz crystals
	604.8			S	"	"	O	"	No	W	" Broken rock
	605.3			P	"	SR	O	"	"	SW	Vuggy Broken rock
	605.5			S	"	"	O	"	"	"	Broken rock

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-4

PAGE 7

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERAL-IZATION	WEATHERING	REMARKS
Run 12	606.4 –	616.7									
1	606.5			P	0°	SR	O	No	No	Un	
2	607.3			P	"	"	mt	"	"	"	
3	608.05			U	"	R	O	"	Qtz	SW	Vuggy.
4	608.4			P	"	SR	O	"	No	Un	flaked
5	608.42			S	"	R	mt	"	"	Un	
6	608.8			P	"	"	"	"	"	"	
7	609.4			P	"	"	"	"	"	SW	
8	609.8			S	"	"	"	"	"	"	
9	610.1			S	10°	"	"	"	"	"	Vuggy @ bottom wall
10	610.7			S	10°	"	O	"	Qtz	"	Vuggy walls
											* Core breaks upon
											handling 608.4 – 608.8
11	611.1			P	0°	Polished	mt	No	No	Un	
12	611.2			P	"	R	O	"	"	SW	Crushed rock at bott. wall
13	611.55 –	612.65		P	"	SR	O	"	"	"	deteriorated flakes
14	611.8			P	"	"	mt	"	"	Un	
15	612.35			U	"	"	"	"	"	"	
16	612.65			P	"	"	"	"	"	"	
17	613.25			P	"	"	"	"	"	"	
18	613.8			P	"	"	"	"	"	"	
19	614.65			U	"	"	"	"	"	"	
20	615.15			U	10°	"	"	"	"	"	
21	615.65			P	0°	R	"	"	"	"	

JOINT CLASSIFICATION LOG

DATE: ______

ELEV. TOP OF HOLE ______ PROJECT NAME ______ CORE BORING NO. CS-4

PAGE 8

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPERITY	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
22	616.1			S	10°	R	mt	No	No	Un	
23	616.55			U	0°	SR	"	"	"	"	
Run 13	616.7 –	626.85									
	617.35 –	617.4		U	5°	SR	mt	No	No	Un	3-4 mm shale flakes
	618			U	10°	sm	"	"	"	"	shale lens
	619.3			U	15°	"	"	"		"	" "
	620.25			P	20°	"	"	"	"	"	" "
	621.35			U	15°	"	"	"	"	"	" "
	622.1			P	15°	"	"	"	"	sw	" "
	624.2						"	"	"		mB
	624.35			U	15°	sm	"	"	"	Un	shale lens
	624.95			P	10°	pl	"	"	"	"	" "
	626.3			U	15°	sm	"	"	"	"	" "
	622.85										mB
Run 14	626.85 –	636.75									
1	628.3			P	0°	sm	mt	No	No	Un	
2	629.7			S	"	R	"	"	"	"	shale lens
3	634.6			P	"	sm	"	"	"	"	
	BOH @	636.75									

Appendix B

Rock Test Results

Table 4.1a

Summary of Laboratory Test Results for
Borehole PV at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
JULY 30, 1991

SAMPLE NUMBER (UTP)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
PV17	17.8- 18.2		1100	3.10	0.03	155.4	5.8	12.8				SHALE	7600	8200	8300 8000	8300 8200	8200 8200
PV26	26.8- 27.1		1000	3.93	0.02	155.9	5.9	12.7				SHALE	7600	8100	8000 8300	8200 8100	8100 8100
PV36	37.0- 37.3		600	3.93	0.02	155.7	6.2	13.0				SHALE	7600	8200	8300 8000	8300 8200	8200 8200
PV45	45.2- 45.5		500	4.12	0.01	154.8	7.2	14.3				SHALE	7300	7800	7800 7800	7800 7800	7700 7800
PV56	56.0- 56.3		500	4.00	0.01	155.8	6.6	13.3				SHALE	7400	7900	7900 7900	7900 7800	7900 7800
PV67	67.1- 67.4		500	3.24	0.01	157.0	5.7	11.9				SHALE	7600	8600	8700 8800	8500 8800	8500 8400
PV74	75.0- 75.3		1000	2.98	0.03	158.6	5.2	10.5				SHALE	8100	8900	9300 9000	8900 8600	8800 8600

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.1b

Summary of Laboratory Test Results for
Borehole PH at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
JULY 30, 1991

SAMPLE NUMBER (UTP)	REACH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
PH17	17.5- 17.8		900	1.61	0.05	158.3	5.4	10.9				SHALE	8500	8300	8600 8200	8600 8000	8500 7900
PH26	26.7- 27.0		1100	1.70	0.07	158.0	4.9	10.6				SHALE	8600	8600	8300 8900	8400 9000	8200 8800
PH32	32.3- 32.5		1100	1.33	0.08	159.8	4.9	9.6				SHALE	8600	8600	8500 8800	8700 8800	8200 8800
PH44	44.4- 44.7		1200	1.43	0.09	158.7	4.9	10.2				SHALE	6500	8700	8500 9000	8500 8800	8500 9000
PH66	66.1- 66.4		1200	1.20	0.10	158.8	4.5	9.8				SHALE	6800	8900	8800 8900	8900 8500	9000 9000
PH89	89.2- 89.5		800	1.45	0.06	158.4	5.1	10.5				SHALE	6400	8700	8200 8800	8100 9000	8300 9500
PH101	101.9- 102.2		1000	1.55	0.06	159.5	4.5	9.4				SHALE	9000	9000	8500 9500	8500 9600	8600 9500
PH121	121.7- 122.0		600	2.62	0.06	159.0	5.1	10.2				SHALE	8700	8900	8500 9200	8700 9300	8700 9200
PH145	146.2		1000	0.80	0.14	161.5	4.3	8.1				SHALE	9500	9500	9700 9400	9200 9600	9600 9400
PH160	160.0- 160.3		800	1.36	0.09	159.6	4.5	9.3				SHALE	8800	9700	9800 9300	9600 9500	10000 9700

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.2a

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SAMPLE NUMBER (CB-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1	175.1 - 175.6	510.8 - 510.3	7000	1.73	0.35	159.3	4.0	9.1				SHALE	10900	11800	11700 11800	11900 11700	11900 11800
1B	178.9	507.0							9.7	2.76							
2B	189.5	496.4							9.1	2.77							
2	195.1 - 195.6	490.8 - 490.3	5800	1.67	0.43	160.4	3.8	8.3				SHALE	10600	11800	11800 11800	11900 11800	12000 11500
3B	198.6	487.3							10.1	2.77							
4B	208.9	477.0							9.2	2.79							
3	215.0 - 215.5	470.9 - 470.4	4500	1.95	0.29	160.4	4.0	8.5				SHALE	10300	11400	11200 11600	11400 11500	11400 11500
5B	218.9	467.0							9.0	2.76							
6B	228.0	457.9							8.8	2.75							
4	235.6 - 236.1	450.3 - 449.8	4600	1.70	0.30	163.8	3.9	6.5				SHALE	10500	11800	12400 11300	11400 11500	11400 12500
7B	237.6	448.3							8.4	2.75							
8B	248.4	437.5							8.7	2.76							
5	255.8 - 256.3	430.1 - 429.6	2800	1.86	0.14	161.0	4.0	8.2				SHALE	10000	11800	14400 11300	11400 11200	11300 11200
9B	258.6	427.3							9.0	2.78							
10B	268.1	417.8							8.3	2.76							
6	274.0 - 274.5	411.9 - 411.4	3600	2.10	0.13	161.0	4.0	8.2				SHALE	9900	11300	11200 11400	11100 11300	11400 11500
11B	278.8	407.1							8.5	2.77							
12B	289.2	396.7							8.5	2.76							
7	295.3 - 295.8	390.6 - 390.1	4100	1.74	0.19	161.6	3.7	7.6				SHALE	10600	12000	12000 11900	12000 12100	12000 12000
13B	298.9	387.0							8.6	2.77							
14B	308.9	377.0							8.2	2.76							
8	316.1 - 316.5	369.8 - 369.4	4100	1.70	2.31	161.0	3.9	8.1				SHALE	10300	11900	11900 11900	12000 11800	11800 11900
15B	318.9	367.0							10.5	2.88							

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.2b (page 1 of 2)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SAMPLE NUMBER (CB-3)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1B	314.6	394.7							9.0	2.80							
2B	325.0	384.3							8.9	2.78							
1	329.8 - 330.4	379.5 - 378.9	4600	1.99	0.22	160.6	3.9	8.3				SHALE	5400	12000	12000 11900	12000 12000	11900 12200
3B	334.0	375.3							7.4	2.74							
4B	344.0	365.3							9.3	2.78							
2	348.1 - 348.6	361.2 - 360.7	4300	2.04	0.19	161.5	4.0	7.9				SHALE	10200	12100	11900 12200	11700 12200	12400 12200
5B	355.0	354.3							9.9	2.81							
6B	364.3	345.0							9.7	2.79							
3	368.4 - 368.9	340.9 - 340.4	3800	2.08	0.19	161.6	4.3	8.1				SHALE	9500	12300	12200 12200	12500 12400	12300 12300
7B	375.0	334.3							10.1	2.81							
8B	384.6	324.7							8.1	2.75							
4	388.4 - 388.8	320.9 - 320.5	4300	1.98	0.21	161.7	3.9	7.7				SHALE	10100	12800	12800 12700	12800 12700	12800 12800
4A	394.1	315.2							7.5	2.77							
4B	394.4	314.9							7.8	2.75							
4C	404.1	305.2							7.9	2.73							
4D	405.1	304.2							8.1	2.77							
5	409.3 - 409.8	300.0 - 299.5	1000	0.75	0.21	161.8	3.9	7.6				SHALE	9300	12700	12800 12800	12800 12600	12500 12600
5A	415.1	294.2							6.5	2.77							
5B	424.1	285.2							7.2	2.74							
5C	425.6	283.7							7.6	2.77							
6 +	428.4 - 428.8	280.9 - 280.5				160.8	4.6	8.8				SHALE					
6A	434.1	275.2							5.9	2.72							
6B	435.8	273.5							7.5	2.76							
6C	442.8	266.5								2.38							

Table 4.2b (page 2 of 2)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991
(continued)

SAMPLE NUMBER (CB-3)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
6D	445.4	263.9								2.18							
7	450.2 - 450.7	259.1 - 258.6	13900	1.69	1.28	139.2	1.2	18.4				CARBON SHALE	9700	12700	12900 12600	12700 12600	12700 12700
7A	455.1	254.2								2.23							
7B	464.1	245.2								2.43							
8	470.1 - 470.6	239.2 - 238.7	6700	0.90	0.86	145.1	1.7	15.4				CARBON SHALE	9900	13600	14100 13100	13800 13800	12800 14000
8A	475.0	234.3								2.43							
8B	484.6	224.7								2.57							
8C	485.1	224.2								2.53							
9	489.4 - 489.8	219.9 - 219.5	10700	1.40	0.98	147.3	2.0	14.3				CARBON SHALE	10400	13700	13800 13700	13700 13500	13700 13800

+ SPECIMEN WAS TOO BROKEN TO TEST.
* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.2c (page 1 of 2)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SAMPLE NUMBER (CB-4)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1	343.8 - 344.3	346.9 - 346.4	1400	2.85	0.04	161.1	5.5	9.4				SHALE	9200	11600	11500 11500	11700 11700	11700 11500
1B	366.3	344.4							8.1	2.77							
2B	375.4	335.3							8.6	2.79							
2	383.7 - 384.2	327.0 - 326.5	2600	1.80	0.13	161.7	4.3	8.0				SHALE	9400	11800	11700 11900	11800 11900	11800 11500
3B	386.4	324.3							7.0	2.75							
4B	396.3	314.4							6.4	2.78							
3	404.6 - 405.2	306.1 - 305.5	1400	0.31	0.60	199.6	1.2	17.0				SHALE	14600	16400	14100 15100	17700 17700	17300 16700
5B	406.4	304.3							7.6	2.75							
6B	416.3	294.4							6.7	2.74							
4	424.1 - 424.6	286.6 - 286.1	1800	1.49	0.23	142.0	4.4	7.9				SHALE	9900	13000	12900 13000	13100 13000	12900 13000
7B	426.2	284.5							5.8	2.76							
8B	434.2	274.5								2.17							
5	444.2 - 444.7	266.5 - 266.0	15300	2.50	0.95	137.3	1.2	16.4				CARBON SHALE	9600	13000	13000 12900	12800 12800	13400 13300
9B	446.7	264.0								2.24							
10B	456.8	253.9								2.49							
11B	457.0	253.7								2.39							
6	464.2 - 464.7	246.5 - 246.0	7700	1.88	0.57	143.3	1.8	13.3				CARBON SHALE	9500	14200	14200 13900	14400 14500	14000 13900
12B	476.7	234.0								2.45							
7	483.5 - 484.0	227.2 - 226.7	10800	1.38	1.05	151.2	2.2	8.9				CARBON SHALE	11100	14400	14400 14400	14500 14800	14400 14500
13B	487.0	223.7								2.38							
14B	496.8	213.9								2.74							
8	503.9 - 504.4	206.8 - 206.3	6600	1.26	0.84	154.7	1.7	6.3				CARBON SHALE	10900	15200	14700 14700	16200 16000	14700 14700
15B	507.2	203.5								2.50							

Table 4.2c (page 2 of 2)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991
(continued)

SAMPLE NUMBER (CB-4)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4.
16B	517.2	193.5							1.9	2.83	0.02 - 0.02						
9	523.1 - 523.6	187.6 - 187.1	15500	0.85	2.01	165.9	3.2	6.1				LMST	15800	16200	16300 16200	16000 16300	15600 14500
17B	527.2	183.5							5.8	2.81	0.01 - 0.01						
18B	538.6	172.1							5.0	2.84	0.06 - 0.04						
10	541.9 - 542.4	168.8 - 168.3	2700	0.54	0.64	158.0	5.0	11.1				LMST	17500	16700	15500 14400	19100 18900	14000 18100
19B	548.3	162.4							17.8	2.87	311.00 - 297.00						
20B	556.7	154.0							12.8	2.87	94.19 - 30.33						
11	564.8 - 565.1	145.9 - 145.6	12400	0.72	2.05	168.0	2.6	3.2				LMST	17000	17100	17300 17100	17500 17500	16000 16000
21B	567.3	143.4							9.4	2.86	1.43 - 1.35						

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.
** HORIZONTAL (CROSS-AXIS) VALUES; FIRST VALUE IS THE MAXIMUM FOR THE PLUG; SECOND VALUE OBTAINED PERPENDICULAR TO THE FIRST.

Table 4.2d (page 1 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991

SAMPLE NUMBER (CB-5)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1A	404.2	316.8							8.0	2.74							
1	407.5 - 407.9	313.5 - 313.1	2900	1.36	0.36	161.6	4.1	7.9				SHALE	9100	12700	12600 12700	12800 12800	12500 12600
1B	414.7	306.3							4.7	2.76							
1C	425.5	295.5							7.3	2.74							
2	427.5 - 428.0	293.5 - 293.0	1700	1.40	0.26	170.3	4.6	3.4				SHALE	4100	11700	11800 11700	11600 11500	11900 11600
2A	434.9	286.1							8.0	2.73							
2B	445.1	275.9								2.25							
3	446.9 - 447.3	274.1 - 273.7	10700	0.96	1.18	138.5	1.2	15.6				CARBON SHALE	9700	13300	13900 12500	13700 13700	13000 13100
3A	455.2	265.8								2.31							
3B	465.1	255.9								2.44							
4	467.3 - 467.9	253.7 - 253.1	7800	0.82	1.20	149.6	1.6	9.2				CARBON SHALE	9900	14000	14100 13800	14000 14100	13700 14300
4A	476.5	244.5								2.48							
5	486.2 - 486.6	234.8 - 234.4	10200	0.89	1.55	151.6	2.0	8.4				CARBON SHALE	10900	14000	14000 14100	14100 14000	13900 14100
5A	486.8	234.2								2.44							
5B	496.6	224.4								2.58							
5C	505.9	215.1								2.30							
6	506.4 - 506.8	214.6 - 214.2	9400	0.91	1.47	149.9	1.6	9.1				CARBON SHALE	10600	15100	14100 14100	17900 16100	14200 14200
6A	514.6	206.4								2.45							
6B	523.0	198.0							0.9	2.72	0.26 - 0.16						
7	527.6 - 528.1	193.4 - 192.9	15100	0.57	2.77	167.4	2.6	7.3				DOL	16100	16500	16500 16600	16300 16400	16400 16400
7A	535.2	185.8							5.2	2.81	0.14 - 0.07						
7B	544.6	176.4							17.6	2.84	2088. - 2037						

Table 4.2d (page 2 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (CB-5)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
8	544.9 - 545.4	176.1 - 175.6	2400	0.30	1.58	153.4	4.7	16.7				DOL	15700	17000	18400 15500	16400 17800	16000 18000
8A	555.6	165.4							10.4	2.84	6.76 - 5.89						
8B	564.5	156.5							11.1	2.83	12.51 - 9.73						
9	567.7 - 568.2	153.3 - 152.8	18700	0.42	4.64	171.3	1.6	4.2				DOL	18600	18500	18100 18100	18300 18000	18800 18800
9A	571.6	149.4							20.9	2.84	41.67 - 23.31						
9B	582.1	138.9							5.3	2.83	0.06 - 0.06						
10	587.1 - 587.5	133.9 - 133.5	13200	0.47	4.78	170.9	1.8	4.6				DOL	18900	18700	18800 18800	18000 18800	18400 18800
10A	592.4	128.6							4.1	2.84	0.11 - 0.09						
10B	602.9	118.1							6.0	2.84	0.96 - 0.88						
11	607.5 - 607.9	113.5 - 113.1	4800	0.27	2.56	162.4	3.8	11.1				DOL	17700	18700	18400 17600	20400 20400	16500 18600
11A	612.7	108.3							5.2	2.84	0.13 - 0.09						
11B	624.1	96.9							8.0	2.84	0.73 - 0.44						
12	626.6 - 627.1	94.4 - 93.9	6400	0.41	1.79	170.7	2.2	0.9				SHALE	15500	15700	16700 16500	15500 15800	14800 14800
12A	633.5	87.5							8.0	2.78	T/B T/B						
12B	644.3	76.7							8.7	2.89	0.12 - 0.08						
13	646.8 - 647.3	74.2 - 73.7	12300	0.34	3.94	167.7	2.7	3.4				LMST	17400	17600	18900 18600	18600 18400	15600 15300
13A	653.8	67.2							6.5	2.85	0.11 - 0.08						
13B	664.1	56.9							7.3	2.85	0.10 - 0.10						

Table 4.2d (page 3 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (CB-5)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
14	646.6 - 647.0	54.4 - 54.0	18300	0.38	5.76	172.1	1.6	--- +				LMST	19700	19300	19100 19100	19600 19900	18900 19300
14A	674.6	46.6							8.8	2.81	0.61 - 0.51						
15	681.0 - 681.4	40.0 - 39.6	8100	0.48	1.80	167.2	3.1	7.8				DOL	14400	14400	14900 14100	14700 15100	13800 15000
15A	681.7	39.3							9.1	2.82	0.01 - <0.01						

+ A NEGATIVE VALUE WAS CALCULATED (-0.2).
* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.
** HORIZONTAL (CROSS-AXIS) VALUES; FIRST VALUE IS THE MAXIMUM FOR THE PLUG; SECOND VALUE OBTAINED PERPENDICULAR TO THE FIRST.

Table 4.2e (page 1 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991

SAMPLE NUMBER (CB-6)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1	401.5 - 402.0	321.6 - 321.0	2400	1.01	0.27	163.5	3.6	6.4				SHALE					
2	421.2 - 421.8	301.9 - 301.3	1700	1.28	0.18	160.0	4.3	9.0				SHALE					
1B	430.2	292.9							6.4	2.75							
3	440.0 - 440.5	283.1 - 282.6	12100	1.72	0.98	138.3	1.3	15.9				CARBON SHALE	9300	12400	12400 12400	12600 12500	12500 12200
2B	440.7	282.4								2.26							
3B	449.8	273.3								2.26							
4	459.6 - 460.1	263.5 - 263.0	8700	0.85	1.29	153.2	2.1	7.6				CARBON SHALE	10900	13900	14000 13900	14200 14400	13400 13200
4B	460.2	262.9								2.26							
5B	471.0	252.1								2.45							
5	478.5 - 479.1	244.6 - 244.0	10100	0.95	1.37	148.4	2.0	10.4				CARBON SHALE	10600	13900	13900 13900	14000 14000	13900 13700
6B	480.0	243.1								2.42							
7B	489.3	233.8								2.38							
8B	497.8	225.3								2.51							
6	498.7 - 499.1	224.4 - 224.0	7700	0.77	1.30	152.7	2.2	8.0				CARBON SHALE	10300	14400	14400 14400	14400 14400	14300 14300
9B	509.0	214.1								2.32							
7	521.0 - 521.5	202.1 - 201.6	9300	0.42	5.89	169.3	0.3	0.2				LMST	19900	19000	18900 18300	19100 19100	19400 19400
10B	521.7	201.4							0.1	2.74	0.06 - 0.06						
7L	523.1 - 523.6	200.0 - 199.5	9000	0.60	2.50	171.9	1.5	0.1				LMST					
11B	532.0	191.1							5.7	2.81	1132.00 - 205.00						
8	540.0 - 540.6	183.1 - 182.5	4000	0.30	3.07	153.6	5.1	17.0				DOL	17100	16800	17900 17700	16000 18200	16000 15200
12B	541.3	181.8							2.9	2.81	2.57 - 2.35						

Table 4.2e (page 2 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (CB-6)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM** (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
13B	553.7	149.4							8.4	2.84	7.35 - 5.23						
14B	560.8	142.3							9.9	2.84	17.20 - 11.09						
9	561.3 - 561.8	161.8 - 161.3	10200	0.61	2.59	165.6	3.5	9.1				DOL	17000	17200	17200 17400	16700 17700	16500 17600
15B	570.7	152.4							8.4	2.84	18.08 - 8.09						
16B	580.0	143.1							11.4	2.85	5.44 - 1.48						
10	580.2 - 580.7	142.9 - 142.4	13100	0.75	6.67	169.6	2.1	5.7				DOL	19500	18600	18500 18900	18900 18900	18900 17400
17B	589.1	134.0							3.2	2.83	0.11 - 0.04						
11	600.6 - 601.1	122.5 - 122.0	4700	0.75	0.97	163.8	4.0	10.5				DOL	17200	18100	17600 17300	18700 18900	18900 17400
18B	601.4	121.7							10.9	2.85	1515.00 - 622.00						
11L	602.9 - 603.4	120.2 - 119.7	8400	0.80	2.88	162.7	2.0	9.4				DOL					
19B	608.6	114.5							4.8	2.85	0.17 - 0.15						
12	620.7 - 621.2	102.4 - 101.9	9900	0.39	4.00	168.7	2.3	6.3				DOL	16900	17800	18500 17200	17400 18000	17400 18200
20B	622.4	100.7							8.8	2.85	13.77 - 12.87						
21B	629.2	93.9							2.7	2.71							
22B	639.2	83.9							4.4	2.86	1.62 - 0.09						
13	639.4 - 640.0	83.7 - 83.1	18900	0.54	6.74	171.4	1.3	3.9				DOL	20100	19800	19200 19900	19900 19700	20100 19700
13L	640.9 - 641.5	82.2 - 81.6	19500	0.87	2.96	169.9	1.1	4.5				DOL					
23B	650.5	72.4							7.1	2.83	0.10 - 0.04						

Table 4.2e (page 3 of 3)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

									Measured				Sonic Velocities (FT/SEC)				
														Lateral			
															Diameter		
SAMPLE NUMBER (CB-6)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	POROSITY (%)	SPEC GRAV	PERM** (md)	ROCK TYPE	AXIAL	AVERAGE	1/4	1/2	3/4
14	659.9 - 660.5	43.2 - 42.6	14300	0.54	4.17	169.8	1.8	5.3				DOL	19500	18600	18000 18100	19400 19100	18700 18500
24B	661.0	42.1							9.3	2.85	1.68 - 1.26						
25B	670.9	52.2							5.0	2.84	0.05 - 0.02						
15	679.8 - 680.3	43.3 - 42.8	9300	0.61	2.04	165.5	3.6	9.3				SHALEY DOL	14300	14100	14100 13800	14200 14100	13800 14400
26B	680.5	42.6							9.6	2.83	0.14 - 0.05						
27B	689.2	33.9							6.1	2.78	0.44 - 0.22						
16L	699.0 - 699.5	24.1 - 23.6	12200	0.41	3.19	168.8	0.2	0.2				LMST					
16	699.6 - 700.1	23.5 - 23.0	9400	0.72	1.63	165.4	0.3	2.5				LMST	18700	18200	16000 18900	18500 18500	18700 18700
28B	701.0	22.1							0.6	2.74	3.07 - 3.03						
17	720.0 - 720.7	3.1 - 2.4	11200	1.04	1.44	169.2	1.3	1.3				LMST	16700	17100	17200 17100	16900 16500	17600 17200
18	739.3 - 739.8	-16.2 - -16.7	8900	0.69	1.55	169.9	1.3	0.9				LMST	16400	17000	16400 17100	17300 17700	17300 16400

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.
** HORIZONTAL (CROSS-AXIS) VALUES; FIRST VALUE IS THE MAXIMUM FOR THE PLUG; SECOND VALUE OBTAINED PERPENDICULAR TO THE FIRST.

Table 4.2f (page 1 of 6)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991

SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
1	40.7 - 41.1	416.2 - 415.8	1000 +	2.00 +	----	157.5	4.9	10.9				SHALE	8400	9100		9100 8300	9600 9200
2	63.4 - 63.9	393.5 - 393.0	2200	1.88	----	159.8	4.6	9.3				SHALE	9000	9900	9900 9100	10400 9900	10400 9900
3	81.3 - 81.7	375.6 - 375.2	2400	1.86	----	160.0	4.4	9.0				SHALE	8400	10000	10500 9600	9100 9900	10700 9900
4	101.3 - 101.7	355.6 - 355.2	2700	1.96	----	161.5	3.9	7.8				SHALE	8600	10600	10900 9700	10900 10100	11300 10900
5 *	121.4 - 121.8	335.5 - 335.1	2000	1.86	----	161.4	4.2	8.1				SHALE	4200	11200	11000	10800 10900	11600 11500
6	141.3 - 141.7	315.6 - 315.2	2000	1.27	----	161.7	4.4	8.1				SHALE	9000	10900	10600	11500 10200	12000 10300
8 *	178.4 - 178.8	278.5 - 278.1	1600	1.48	0.18	161.0	4.7	8.7				SHALE	8700	11100	10700	10600 10100	12100 11900
9	185.2 - 185.6	271.7 - 271.3	7300	0.85	1.11	134.8	2.0	18.5				CARBON SHALE	9000	12000	11700 11900	10900 12500	12800
10	200.4 - 200.8	256.5 - 256.1	11500	1.27	1.48	142.5	1.3	13.3				CARBON SHALE	6900	12300		12300	12400 12300
11	224.1 - 224.5	232.8 - 232.4	6500	0.55	1.48	147.0	1.9	11.1				CARBON SHALE	10200	12700	13200 12400	13800 12500	13800 10200
39	240.6 - 241.0	216.3 - 215.9	5500	0.73	11.96	162.7	3.0	2.6				CAL SHALE					
40	241.1 - 241.5	215.8 - 215.4	3000	0.50	10.95	155.6	2.3	6.3				CARBON SHALE					
12	241.6 - 242.0	215.3 - 214.9	5200	0.76	0.78	163.6	2.9	2.0				CAL SHALE	11200	13100	13900 12900	14300 11000	14600 11600
13	262.3 - 262.7	194.6 - 194.2	7400	0.44	1.91	145.5	1.1	11.3				SHALE	8300	13900	13900 13800	13900 13900	13900 13900
14	263.2	193.7							2.7	2.84	< 0.01						
14	263.2 - 263.6	193.7 - 193.3	12000	0.24	6.86	170.4	2.7	5.7				DOL	19300	12100	12000 12500	11500 11300	14700 10700
18	267.0	189.9							1.0	2.82	< 0.01						
28	268.7	188.2							0.8	2.72	< 0.01						
38	272.3	184.6							8.6	2.82	< 0.01						
48	274.7	182.2							6.8	2.82	< 0.01						

Table 4.2f (page 2 of 6)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
15	278.4	178.5							4.6	2.79	< 0.01						
15	278.5 - 278.9	178.4 - 178.0	14600	0.44	3.60	168.0	2.1	6.4				DOL	16300	16500	16400 15400	16600 16600	17100 17100
5B	279.0	177.9							5.6	2.81	< 0.01						
6B	282.5	174.4							5.3	2.80	< 0.01						
7B	284.8	172.1							5.8	2.82	< 0.01						
8B	287.1	169.8							6.1	2.83	< 0.01						
9B	288.9	168.0							8.9	2.81	0.27						
10B	290.5	166.4							2.4	2.83	< 0.01						
16	292.2 - 292.6	164.7 - 164.3	7600	0.24	4.07	170.0	1.3	4.7				DOL	19500	14500	10100	18000 14800	14900 14700
16A *	292.6 - 293.0	164.3 - 163.9	3900	0.76	1.60	163.3	2.1	8.0				DOL	2600	13600	17300	11800 14500	10700
11B	292.9	164.0							7.5	2.82	99.36						
16	293.1	163.8							6.0	2.82	21.64						
30	296.8 - 297.2	160.1 - 159.7	5800	0.24	4.33	163.8	3.7	10.2				DOL	19000	13700		10900 16000	17200 10700
3B	297.2	159.7							6.6	2.81	53.70						
33	297.3 - 297.7	159.6 - 159.2	9700	0.15	10.09	162.8	3.2	10.4				DOL					
34	297.7 - 298.1	159.2 - 158.8	7700	0.18	6.76	163.8	3.5	10.1				DOL					
12B	298.2	158.7							12.3	2.82	322.00						
13B	300.0	156.9							14.2	2.83	126.00						
14B	302.0	154.9							7.5	2.83	0.60						
15B	305.0	151.9							6.7	2.82	0.02						
16B	306.5	150.4							6.1	2.84	6.72						
17B	310.0	146.9							5.2	2.84	0.03						
18B	311.7	145.2							8.3	2.85	0.05						
19B	313.7	143.2							16.2	2.83	57.60						

Table 4.2f (page 3 of 6)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
20B	316.5	140.4							16.8	2.77	152.00						
21B	318.7	138.2							9.2	2.84	0.06						
17	321.4	135.5							10.3	2.82	0.02						
17	321.5 - 321.9	135.4 - 135.0	9900	0.32	3.80	163.3	4.2	10.9				DOL	12300	12800		13000	12200 13200
22B	322.0	134.9							10.9	2.83	0.02						
23B	324.6	132.3							7.7	2.84	0.11						
24B	326.0	130.9							8.3	2.84	0.95						
25B	329.6	127.3							3.7	2.85	0.02						
26B	331.2	125.7							2.9	2.84	< 0.01						
27B	333.6	123.3							3.7	2.83	< 0.01						
28B	336.6	120.3							2.0	2.83	0.01						
18A	340.6	116.3							2.2	2.82	< 0.01						
18	340.7	116.2							2.5	2.82	0.01						
18	341.7 - 342.2	115.2 - 114.7	20700	0.32	8.96	172.3	0.9	2.9				LMST/ DOL	20000	18700		17400	19700 19000
37	342.2 - 342.5	114.7 - 114.4	9400	0.14	10.46	173.2	0.6	2.2				LMST/ DOL					
38	342.5 - 342.9	114.4 - 114.0	13600	0.34	6.23	172.5	0.6	2.6				LMST/ DOL					
29B	343.3	113.6							2.6	2.82	0.02						
30B	344.7	112.2							2.0	2.81	< 0.01						
31B	347.2	109.7							6.1	2.85	1.03						
31	351.6	105.3							4.4	2.85	1.47						
31	351.8 - 352.2	105.1 - 104.7	4700	0.22	5.61	164.9	3.7	9.6				DOL	18500	13600	14200 17600	10400 13600	14100
35	352.3 - 352.7	104.6 - 104.2	5200	0.17	6.54	159.7	4.6	13.3				DOL					
32B	352.9	104.0							12.9	2.84	167.00						

Table 4.2f (page 4 of 6)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

									MEASURED				SONIC VELOCITIES (FT/SEC)				
														LATERAL			
															DIAMETER		
SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	POROSITY (%)	SPEC GRAV	PERM (md)	ROCK TYPE	AXIAL	AVERAGE	1/4	1/2	3/4
36	353.1 - 353.5	103.8 - 103.4	6200	0.28	4.06	163.5	3.6	10.3				DOL					
33B	357.7	99.2							5.5	2.90	0.02						
19	362.1	94.8							4.2	2.83	< 0.01						
19	362.2 - 362.6	94.7 - 94.3	11000	0.26	5.37	171.5	1.5	3.9				DOL	17900	14700	16700 10200	18000 10700	18000 14600
34B	362.8	94.1							5.9	2.83	< 0.01						
35B	364.7	92.2							5.8	2.83	< 0.01						
36B	366.6	90.3							17.9	2.85	46.92						
20	373.2 - 373.6	83.7 - 83.3	2700	0.49	0.38	166.8	2.9	3.8				SHALE	10900	13600	14300	13300 12700	13100 14400
38B	382.0	74.9							3.3	2.83	< 0.01						
39B	384.0	72.9							7.7	2.84	0.21						
40B	386.0	70.9							4.0	2.84	< 0.01						
41B	388.7	68.2							4.8	2.83	0.02						
42B	393.0	63.9							7.3	2.83	0.02						
21	394.9	62.0							8.4	2.83	0.02						
21	395.0 - 395.4	61.9 - 61.5	15000	0.32	6.41	168.0	2.5	6.9				DOL	17300	12500	10200 11800	14100	13800
43B	395.5	61.4							7.1	2.84	0.02						
44B	398.2	58.7							7.1	2.83	0.02						
45B	400.1	56.8							7.7	2.83	0.08						
32 *	404.3 - 404.7	52.6 - 52.2	10800	0.38	4.64	168.5	2.6	6.7				DOL	11400	14900	16500	16200 18100	16000 15800
32	404.7	52.2							11.3	2.84	6.31						
46B	405.9	51.0							4.8	2.84	0.01						
47B	409.2	47.7							6.0	2.84	0.35						
22	410.4	46.5							6.8	2.85	0.83						
22	410.5 - 410.9	46.4 - 46.0	13100	0.21	7.55	167.6	2.6	7.2				DOL	19100	16600	17000 14500	18300 13800	19200

Table 4.2f (page 5 of 6)

PORT KNOX, KENTUCKY -- ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	SONIC VELOCITIES LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
48B	412.6	44.3							8.1	2.86	11.76						
49B	417.7	39.2							7.3	2.85	< 0.01						
50B	419.9	37.0							6.1	2.84	0.01						
51B	422.0	34.9							5.1	2.84	0.02						
23	425.7	31.2							7.4	2.82	0.01						
23	425.8 - 426.2	31.1 - 30.7	8000	0.36	3.12	167.9	2.9	7.2				SHALEY DOL	15200	13000	10900	11900 14100	15000
53B	426.4	30.5							7.7	2.83	0.02						
24	430.9 - 431.3	26.0 - 25.6	5400	0.33	1.96	166.7	3.0	8.0				DOL	14300	15400		15300 15400	
24	431.5	25.4							8.7	2.81	< 0.01						
52B	431.8	25.1							6.2	2.79	0.10						
54B	434.2	22.7							8.0	2.82	< 0.01						
55B	440.5	16.4							7.3	2.83	< 0.01						
56B	443.0	13.9							1.7	2.73	0.02						
57B	446.7	10.2							3.6	2.73	0.02						
58B	447.8	9.1							1.9	2.74	0.01						
25	448.3 - 448.7	8.6 - 8.2	10000	0.25	6.25	167.2	0.3	1.4				SHALEY LMST	19600	13800	16600 10600	10600 12700	18800 13200
25	448.8	8.1							0.8	2.71	< 0.01						
60B	452.2	4.7							1.5	2.74	< 0.01						
61B	454.5	2.4							2.6	2.76	0.03						
62B	456.7	0.2							4.6	2.82	< 0.01						
26	458.7 - 459.1	-1.8 - -2.2	7200	0.34	3.11	168.9	1.2	1.3				LMST/ SHALE	16100	15200	14100	16400 13700	16400
26	459.2	-2.3							1.8	2.75	< 0.01						
63B	459.4	-2.5							2.7	2.77	< 0.01						
64B	461.6	-4.7							3.4	2.79	< 0.01						

Table 4.2f (page 6 of 6)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X E06 (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED POROSITY (%)	MEASURED SPEC GRAV	MEASURED PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC) AXIAL	LATERAL AVERAGE	LATERAL DIAMETER 1/4	LATERAL DIAMETER 1/2	LATERAL DIAMETER 3/4
65B	465.0	-8.1							3.4	2.78	0.04						
27	468.0 - 468.4	-11.1 - -11.5	8000	0.30	3.34	167.6	2.5	2.9				SHALE	15400	13500	11400	14400	15500 12800
27	468.5	-11.6							5.7	2.80	< 0.01						
66B	473.2	-16.3							3.3	2.78	< 0.01						
67B	476.1	-19.2							2.8	2.73	0.03						
68B	479.0	-22.1							2.3	2.75	< 0.01						
28	480.4	-23.5							3.5	2.79	0.02						
28	480.5 - 480.9	-23.6 - -24.0	11700	0.32	4.57	169.2	0.9	0.8				LMST/ SHALE	17700	12800	13800 10300	13600 12200	10300 16400
69B	482.4	-25.5							3.6	2.79	< 0.01						
70B	485.0	-28.1							1.6	2.72	< 0.01						
71B	488.4	-31.5							4.3	2.82	< 0.01						
72B	490.7	-33.8							3.4	2.79	< 0.01						
73B	493.0	-36.1							2.0	2.74	< 0.01						
74B	496.5	-39.6							1.9	2.74	< 0.01						
75B	498.2	-41.3							3.1	2.77	< 0.01						
76B	499.5	-42.6							3.3	2.78	< 0.01						
29	499.7 - 500.1	-42.8 - -43.2	8000	0.32	3.09	168.7	1.2	1.5				LMST	16200	13800	12000 13700	15600	
29	500.2	-43.3							1.1	2.73	0.01						
77B	502.0	-45.1							3.0	2.77	< 0.01						
78B	504.5	-47.6							1.5	2.74	< 0.01						

+ SPECIMEN WAS NOT TAKEN TO FAILURE.
* SPECIMEN HAD PRETEST HORIZONTAL FRACTURE.
** ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Figure 4.1

Summary of Laboratory Test Results for Rock Cores
from Boring CB-1, Ft. Knox, KY

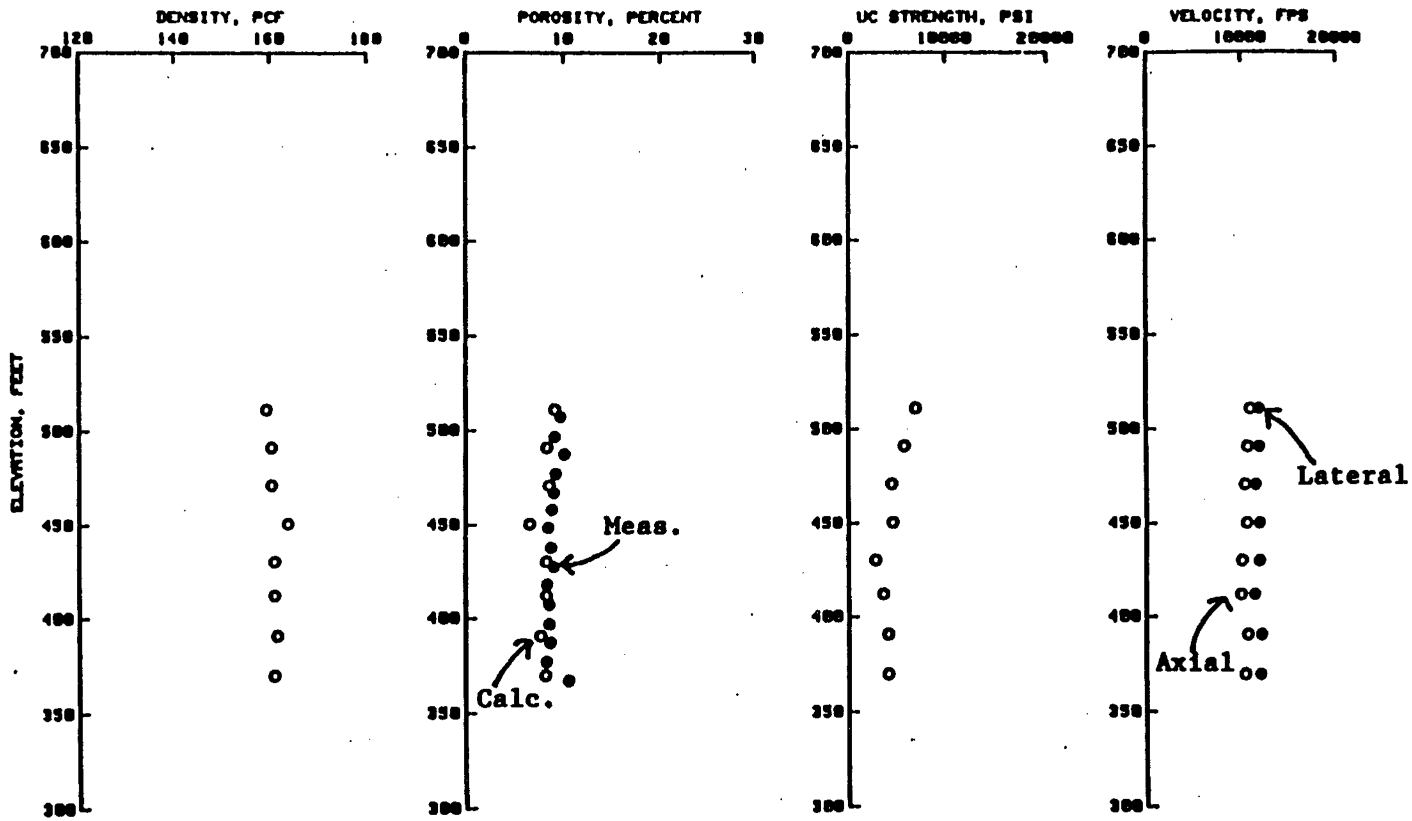


Figure 4.2

Summary of Laboratory Test Results for Rock Cores
from Boring CB-3, Ft. Knox, KY

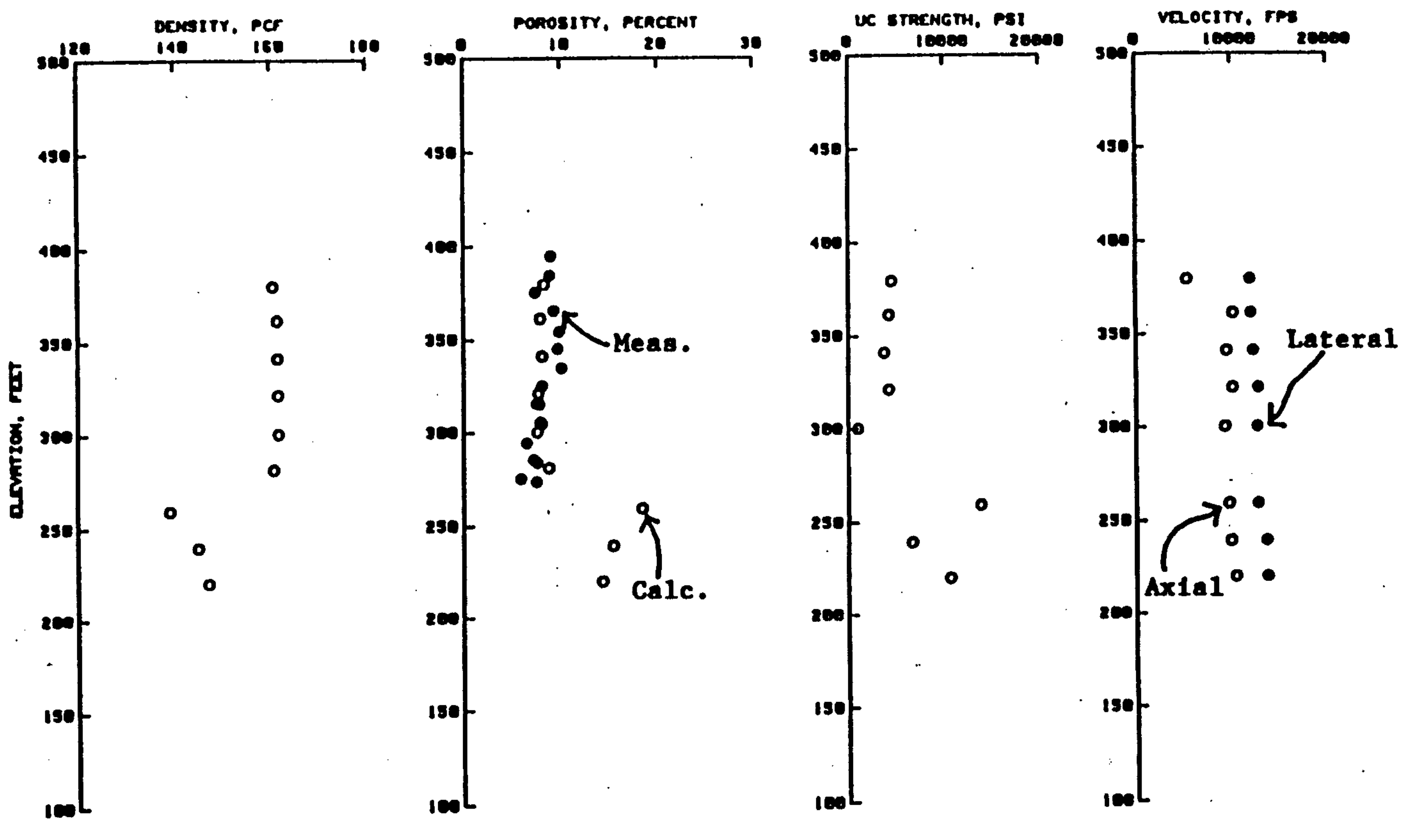


Figure 4.3

Summary of Laboratory Test Results for Rock Cores
from Boring CB-4, Ft. Knox, KY

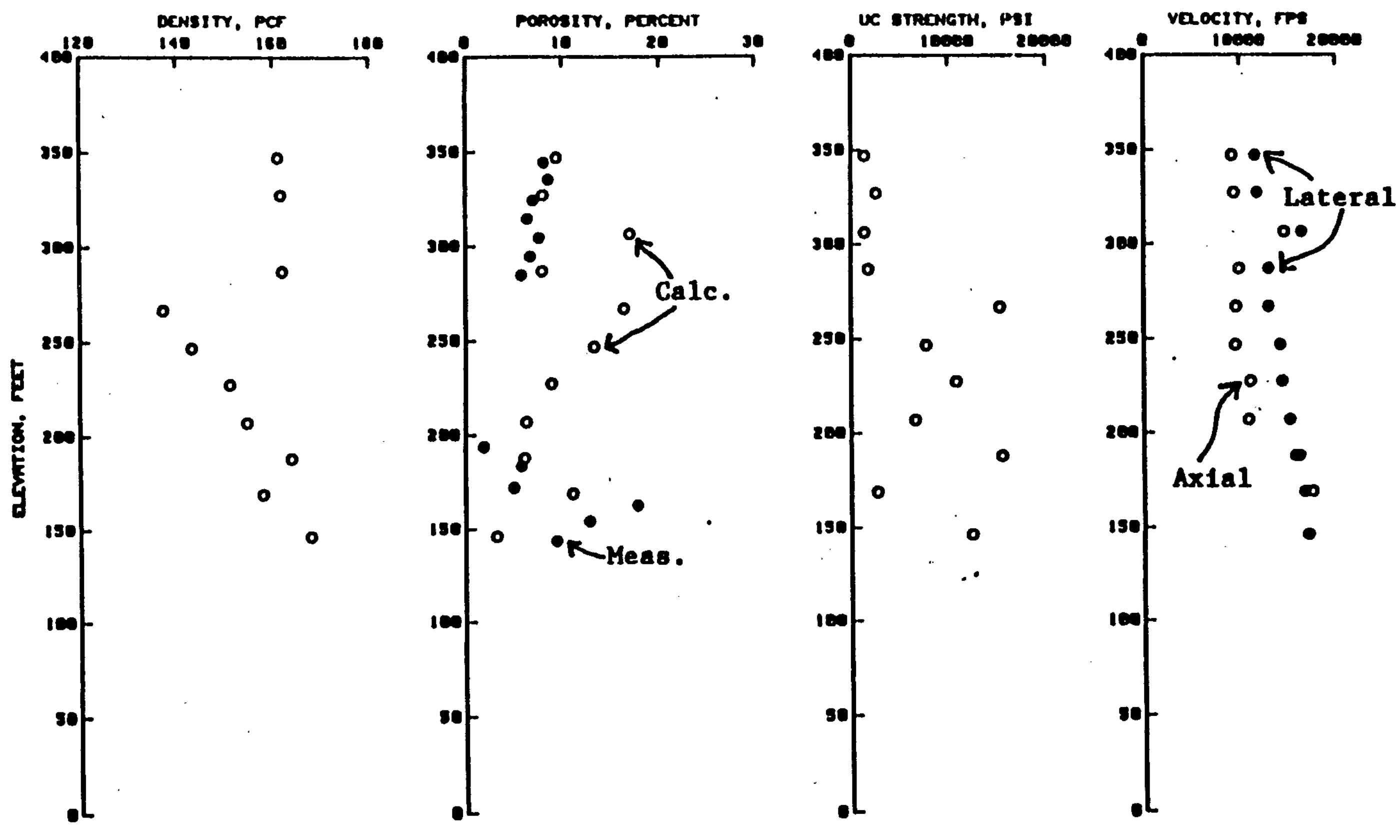


Figure 4.4

Summary of Laboratory Test Results for Rock Cores
from Boring CB-5, Ft. Knox, KY

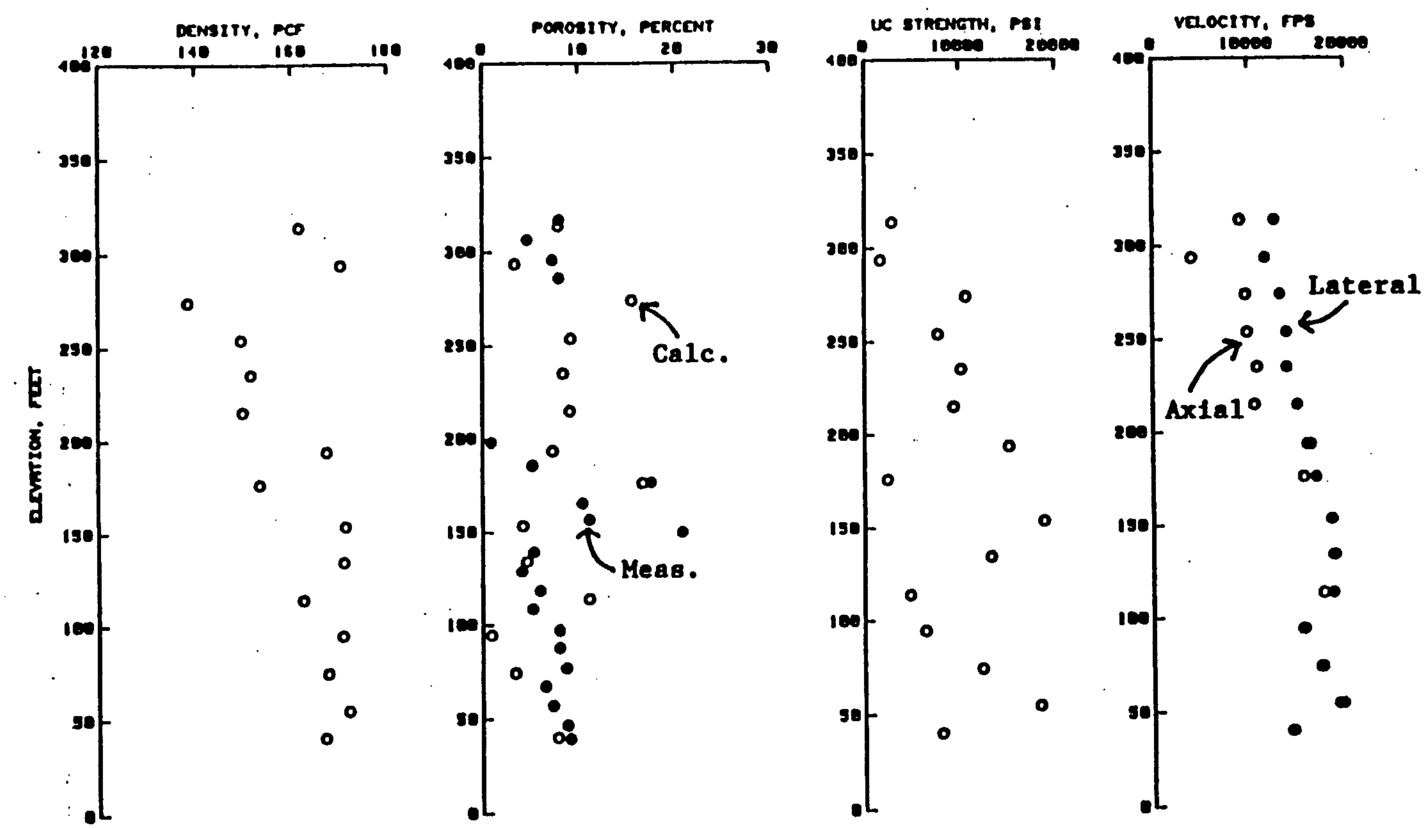


Figure 4.5

Summary of Laboratory Test Results for Rock Cores
from Boring CB-6, Ft. Knox, KY

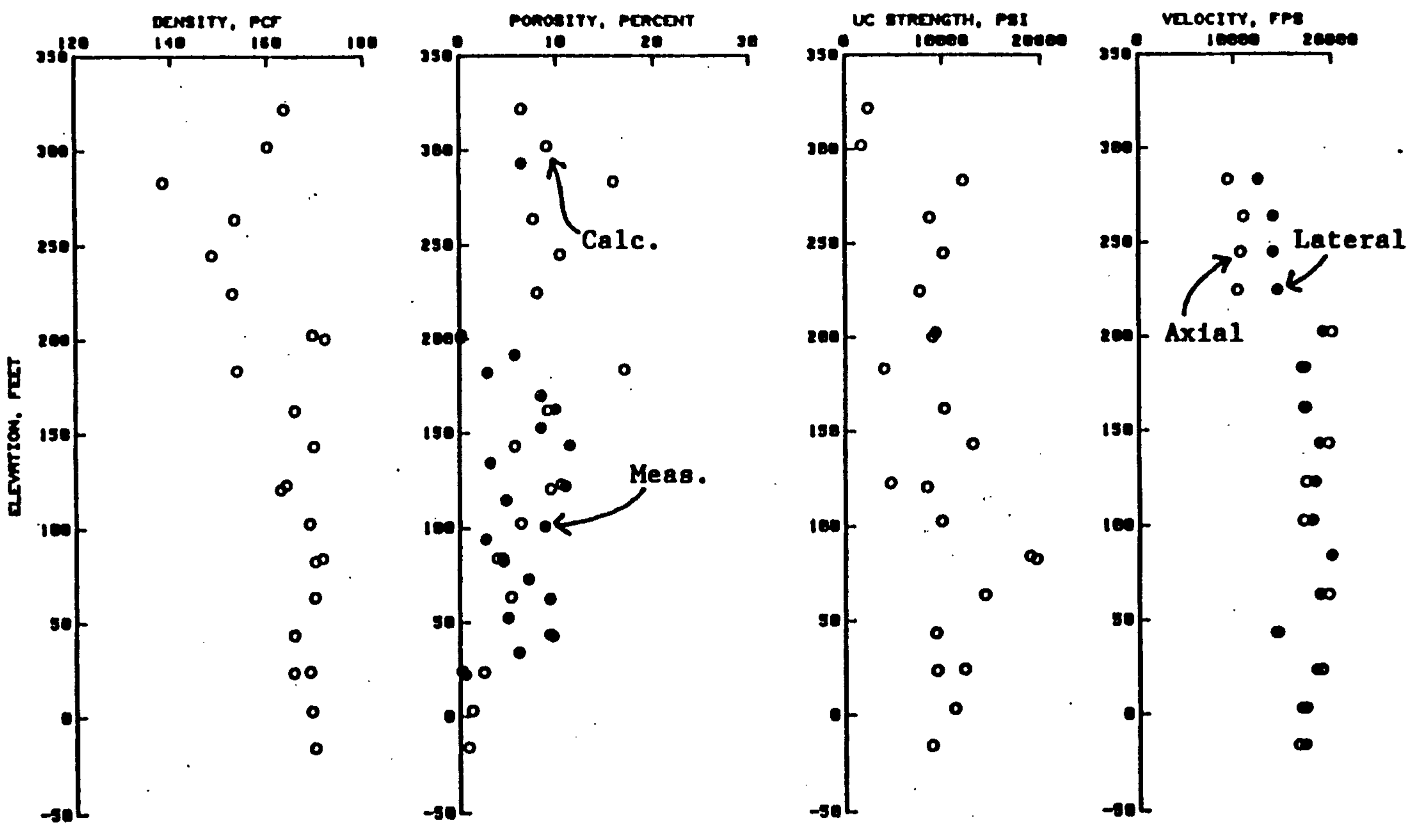


Figure 4.6

Summary of Laboratory Test Results for Rock Cores from Boring FK-1, Ft. Knox, KY

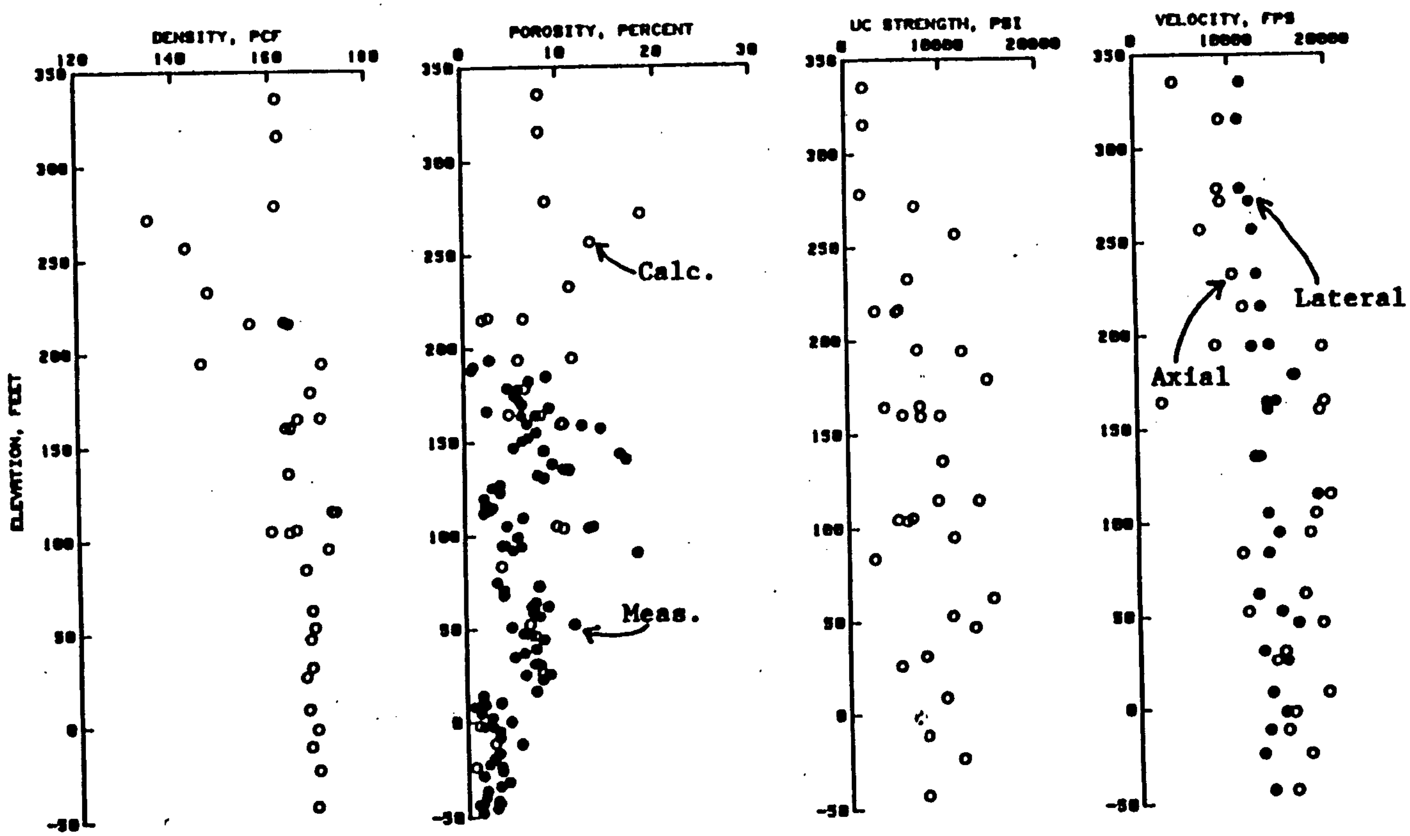


Table 4.3

SUMMARY OF RESULTS OF TENSILE TESTS ON SHALE CORES FROM UTP BORINGS CB-1, CB-3, AND CB-4 (UPDATED 6/17/91)

Boring No.	Depth (feet)	Dia. (in.)	Ht (in.)	Load (lbs)	Weight (grams)	Wet Density (pcf)	Water Content (%)	Dry Density (pcf)	Indirect Tensile Strength (psi)	Direct Tensile Strength (psi)
CB-1	175.65	1.762	0.964	1506	97.42	157.9	4.23	151.5	564.4	–
	190.80	1.763	0.961	1007	96.91	157.4	4.15	151.1	378.4	–
	206.00	1.760	1.028	980	104.53	159.2	4.23	152.8	344.8	–
	220.35	1.759	0.967	908	96.97	157.2	4.05	151.1	339.8	–
	265.45	1.760	0.959	608	96.71	157.9	4.54	151.1	229.3	–
	279.85	1.762	1.000	599	102.05	159.4	4.67	152.3	216.4	–
	279.95	1.757	0.982	808	100.19	160.3	4.24	153.8	298.1	–
	285.50	1.757	0.933	880	95.63	161.0	3.59	155.5	341.8	–
	291.55	1.756	0.989	735	100.68	160.1	3.75	154.3	269.4	–
	294.10	1.761	0.938	653	95.43	159.1	3.85	153.2	251.7	–
	295.25	1.751	0.942	762	95.41	160.2	4.11	153.9	294.1	–
	299.65	1.757	0.977	626	99.22	159.6	4.12	153.3	232.2	–
	304.70	1.759	0.978	494	103.39	165.7	3.68	159.8	182.8	–
	309.50	1.763	0.887	662	89.99	158.3	4.39	151.7	269.5	–
	309.60	1.759	1.000	708	101.58	159.2	3.78	153.4	256.2	–
CB-3	330.40	1.748	0.941	1134	94.22	158.9	4.22	152.5	438.9	–
	345.05	1.762	1.005	1171	102.31	159.0	4.30	152.5	421.0	–
	360.00	1.763	0.969	1180	97.66	157.3	4.62	150.3	439.7	–
	374.85	1.759	0.992	1370	100.73	159.2	4.48	152.4	499.8	–
	390.10	1.759	1.002	1624	102.58	160.5	4.34	153.8	586.6	–
	405.05	1.762	0.956	726	96.39	157.5	4.38	150.9	274.4	–
	411.50	1.728	0.901	563	89.19	160.8	4.28	154.2	230.2	–
	414.80	1.758	0.989	1071	101.14	160.5	4.32	153.9	392.2	–
	420.25	1.761	1.062	1271	109.65	161.5	3.91	155.4	432.7	–
	425.50	1.761	0.953	1162	97.83	160.6	4.58	153.5	440.8	–
	430.40	1.759	1.035	1198	106.18	160.8	4.42	154.0	418.9	–
	435.50	1.760	1.070	1316	108.72	159.1	4.30	152.5	444.9	–
	440.60	1.762	0.979	2949	82.56	131.8	1.99	129.2	1088.3	–
	445.10	1.763	1.005	2931	93.67	145.5	1.30	143.6	1053.1	–
	450.70	1.765	1.056	3866	95.18	140.3	1.10	138.8	1320.5	–
	465.05	1.763	1.003	2078	97.63	151.9	2.01	148.9	748.1	–
	479.40	1.762	0.961	2514	88.37	143.7	2.12	140.7	945.2	–
CB-4	366.60	1.865	1.000	944	114.27	159.4	4.26	152.8	322.2	–
	380.15	1.864	0.998	1125	114.29	159.9	3.99	153.7	385.0	–
	395.20	1.768	1.005	898	110.07	170.0	3.36	164.4	321.7	–
	409.45	1.762	0.972	1343	99.19	159.4	4.41	152.7	499.2	–
	424.10	1.767	0.994	1143	102.72	160.5	4.61	153.5	414.3	–
	435.00	1.776	4.346	2.4	453.53	160.5	3.05	155.7	–	1.0
	439.90	1.773	0.993	3394	89.42	138.9	1.40	137.0	1227.3	–
	443.52	1.773	4.305	279.4	373.31	133.8	1.00	132.5	–	113.2
	456.25	1.772	4.232	153.7	393.13	143.5	1.16	141.9	–	62.3
	456.70	1.771	0.957	1815	91.86	148.4	1.75	145.9	681.8	–
	461.70	1.770	1.010	2042	96.83	148.4	1.47	146.3	727.2	–
	466.10	1.774	0.989	2006	94.45	147.2	1.40	145.2	727.9	–
	470.50	1.773	1.014	2504	99.78	151.8	2.21	148.6	886.7	–
	475.30	1.769	4.210	257.2	401.06	147.7	1.87	144.9	–	104.6
	475.60	1.770	1.022	2441	97.01	147.0	1.84	144.3	859.1	–
	480.60	1.758	0.987	2405	101.21	160.9	2.61	156.8	882.4	–
	486.00	1.770	0.940	1815	89.03	146.6	1.83	144.0	694.5	–
	486.30	1.769	4.139	235.6	396.44	148.5	1.85	145.8	–	95.9
	491.10	1.770	0.968	2296	97.02	155.2	2.45	151.5	853.1	–
	495.85	1.767	4.235	261.7	440.13	161.5	2.70	157.2	–	106.7
	500.00	1.771	1.016	2568	[illegible]	146.5	2.23	143.3	908.6	–

Figure 4.7

Tenisle Strength Tests, Boring CB-1

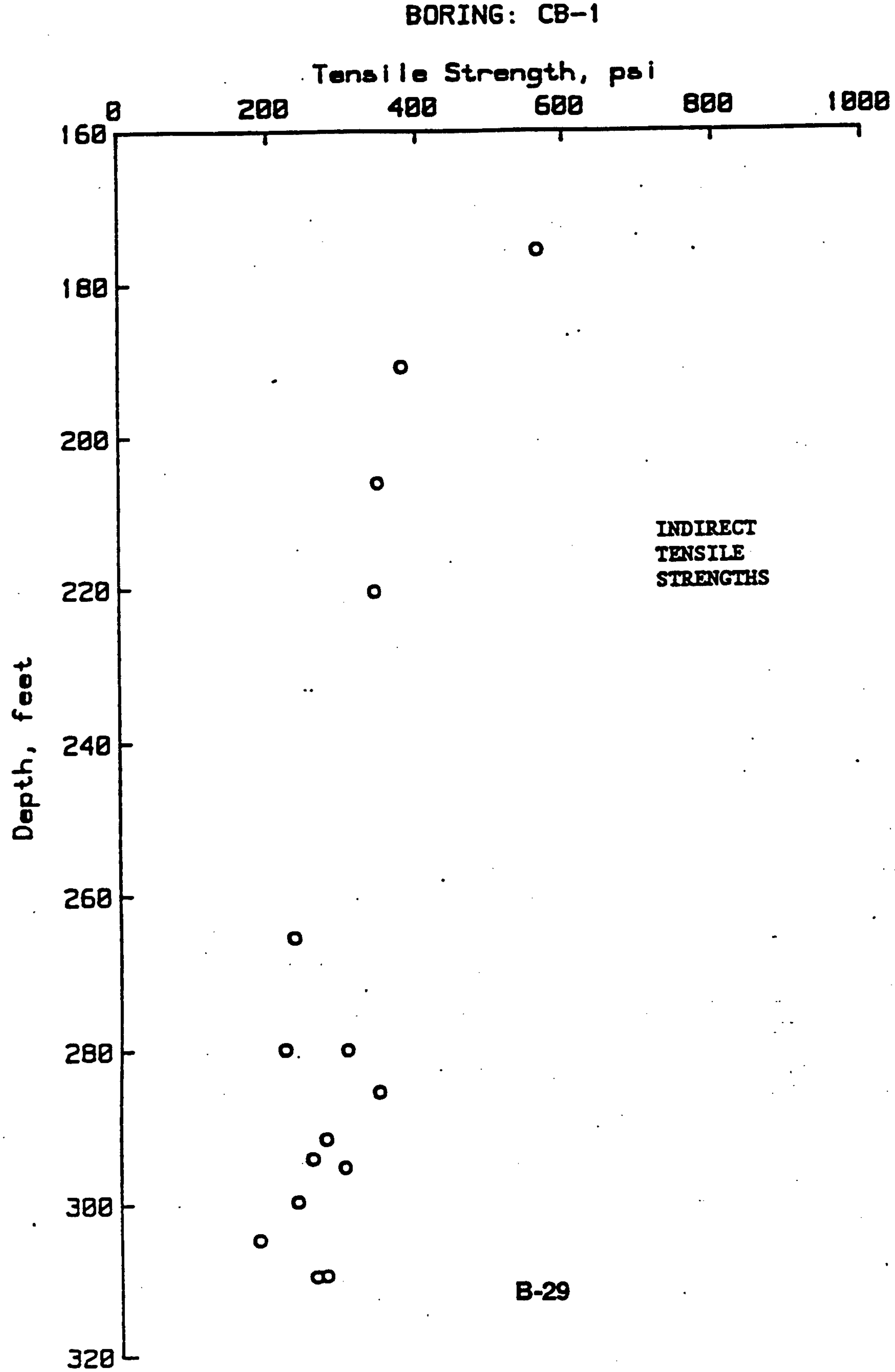
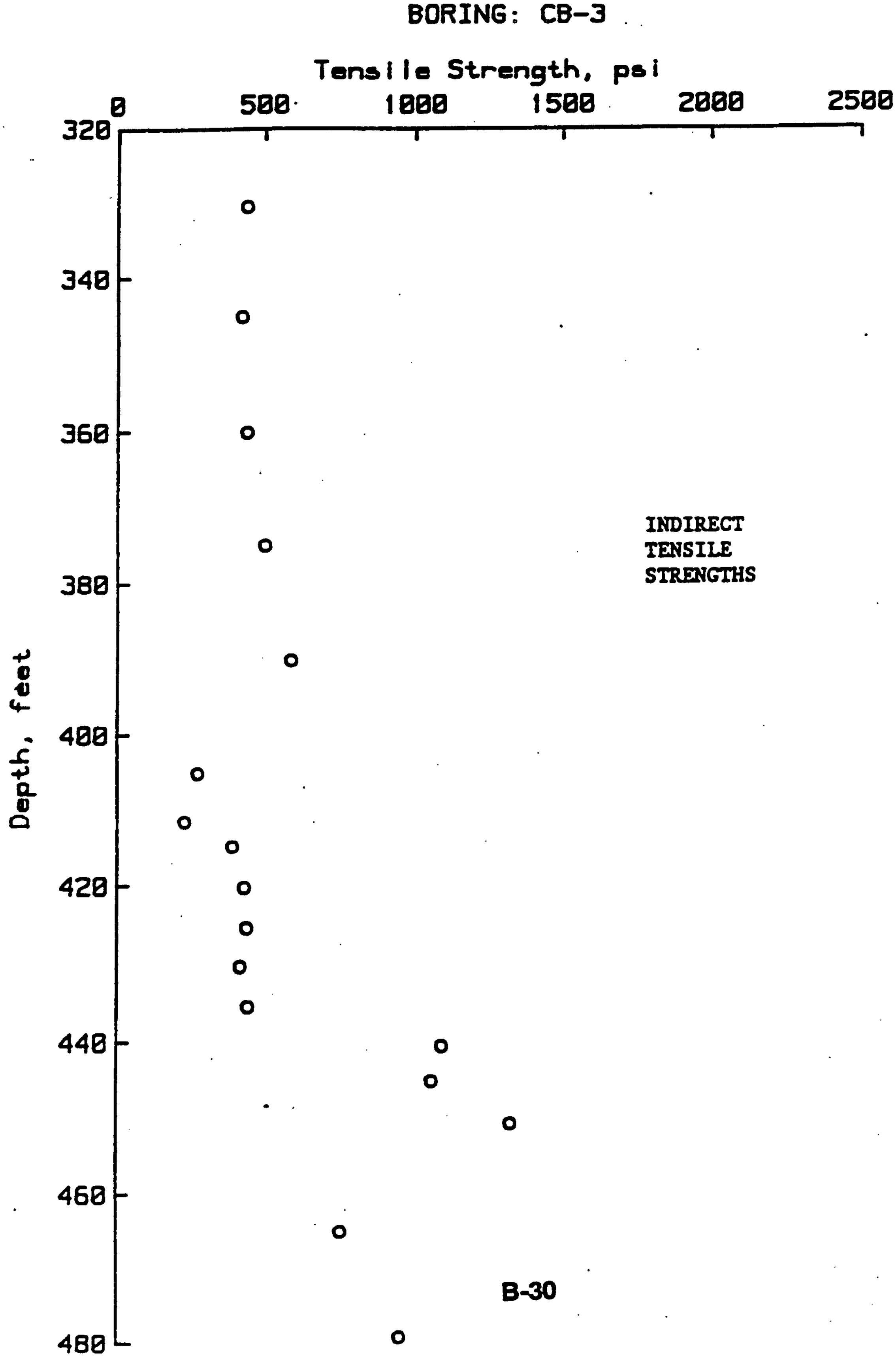


Figure 4.8
Tensile Strength Tests, Boring CB-3



B-30

Tensile Strength Tests, Boring CB-4

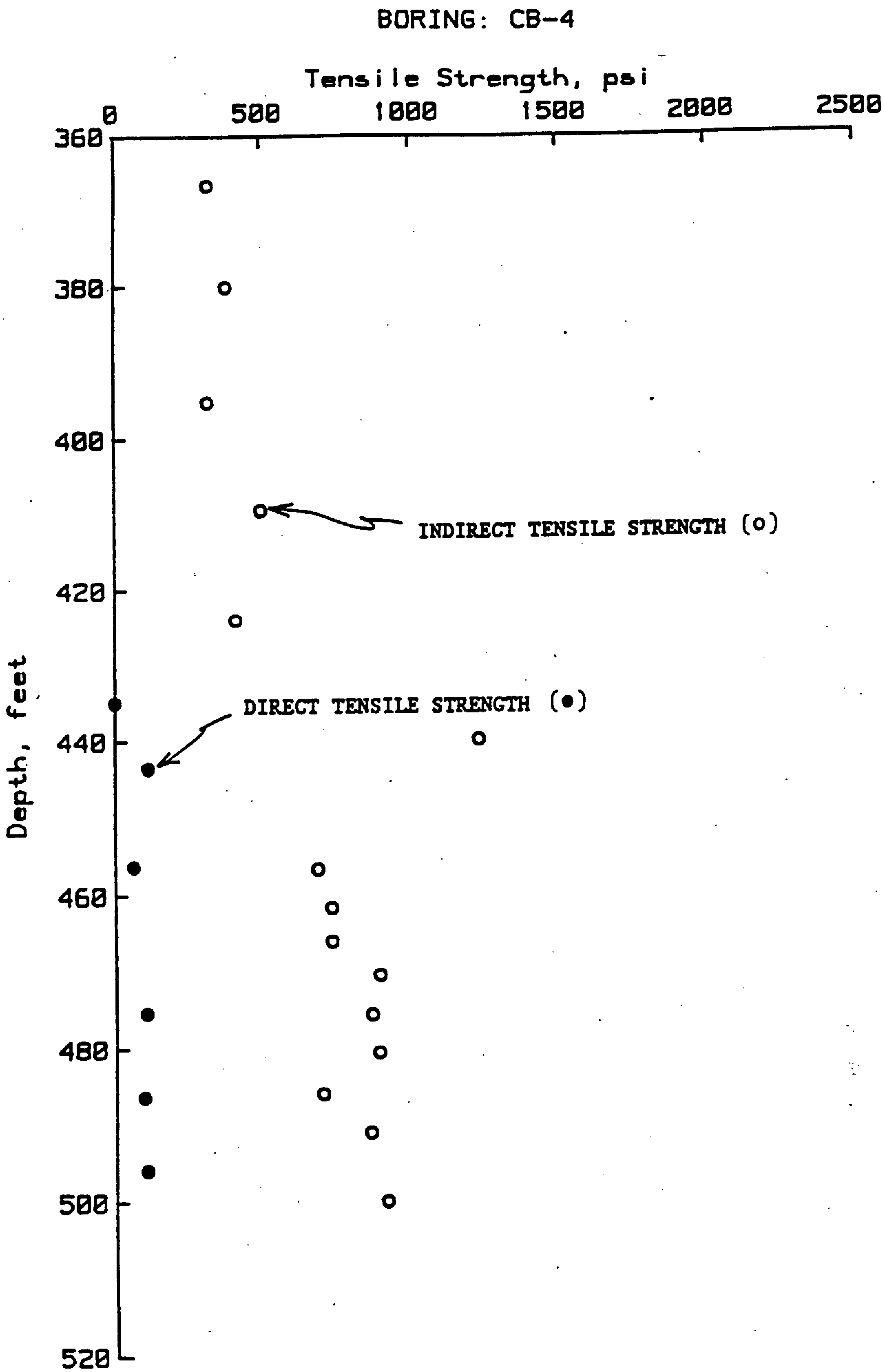


Figure 4.10

Composite Plot of Strength Test Data for CB-1, CB-2,and CB-4

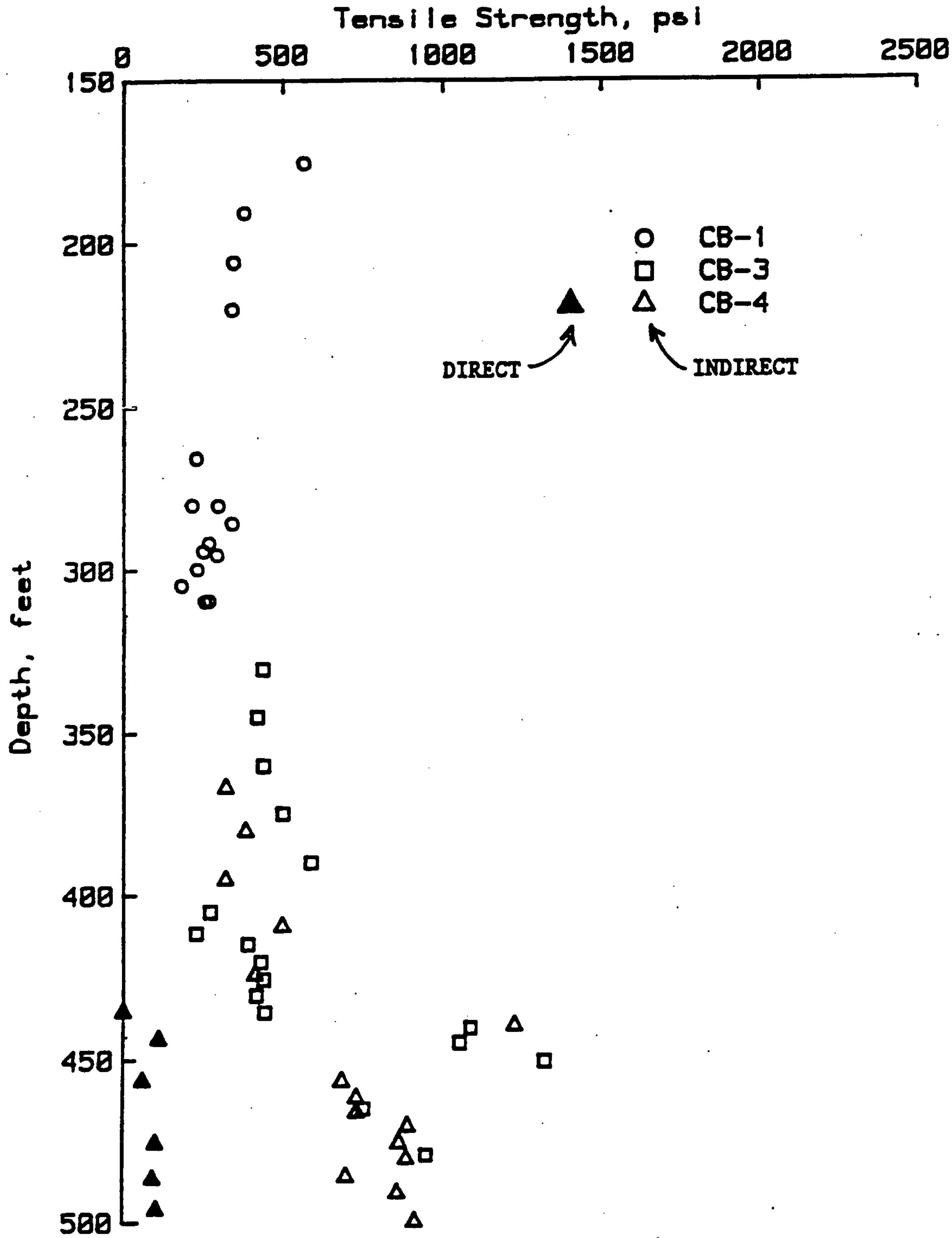


TABLE 4.4

QUANTITATIVE X-RAY DIFFRACTION ANALYSIS

Hole #	Depth (ft)	Formation	Clay-%	Qrtz-%	Fldspr-%	Calc-%	Dolo-%	Other-% +
CB-6	429.9	N. Prov.	5	23	3	<1	5	68
CB-6	453.2	N. Albany	12	19	7	<1	<1	72
CB-6	536.0	Louisville	1	1	-	-	98	1
CB-4	426.0	N. Prov.	12	23	7	<1	<1	68
CB-4	460.2	N. Albany	9	28	7	<1	1	62
CB-4	521.8	Jfsnvl	1	1	-	78	20	1
CB-4	555.5	Louisville	1	2	-	<1	97	1

+ Other represents all "other" material not detected by X-ray diffraction analysis, e.g. organics and amorphous material such as glass

Appendix C

Geologic Maps

Job No. | No

LACHEL & Associates, Inc.
Geologists, Engineers

Project: UTP – Ft. Knox, KY		Computed: G. Alsayab	Date:
Subject: Geological Mapping of Tunnel		Checked:	Date:
Task:		Sheet: 1	Of: 72

* Geological Mapping was done according to the "Full Periphery Method" which is explained in the Engineer Technical Letter No. 1110 - 1 - 37, published by Dept. of the Army - Office of the Chief of Engineers - Washington, D.C. 2031 and dated 18 Sept. 1970

* In this specific mapping of the UTP tunnel, the assumption that Magnetic Declination @ Ft. Knox, KY is Zero, was utilized and orientation of geologic discontinuities & bedding planes encountered was measured in Magnetic Azimuth using a Brunton Compass.

* Main Tunnel orientation, prior to curve = 335° Az
* Contractor did not maintain station marking along tunnel during excavation. Stations were marked every 100' over shotcrete liner later on.

* Whole tunnel is lined with shotcrete of 2" thickness minimum.

Scale: 1" = 6' horizontal
1" = 5' Along Tunnel Axis

Legend:

? : Estimated

: Cave in cast (fall-out)

: Siderite Nodule or cast

⊙ or ⊡ : Rock dowel

⊠ : Tensioned Rock Bolt

: Seepage

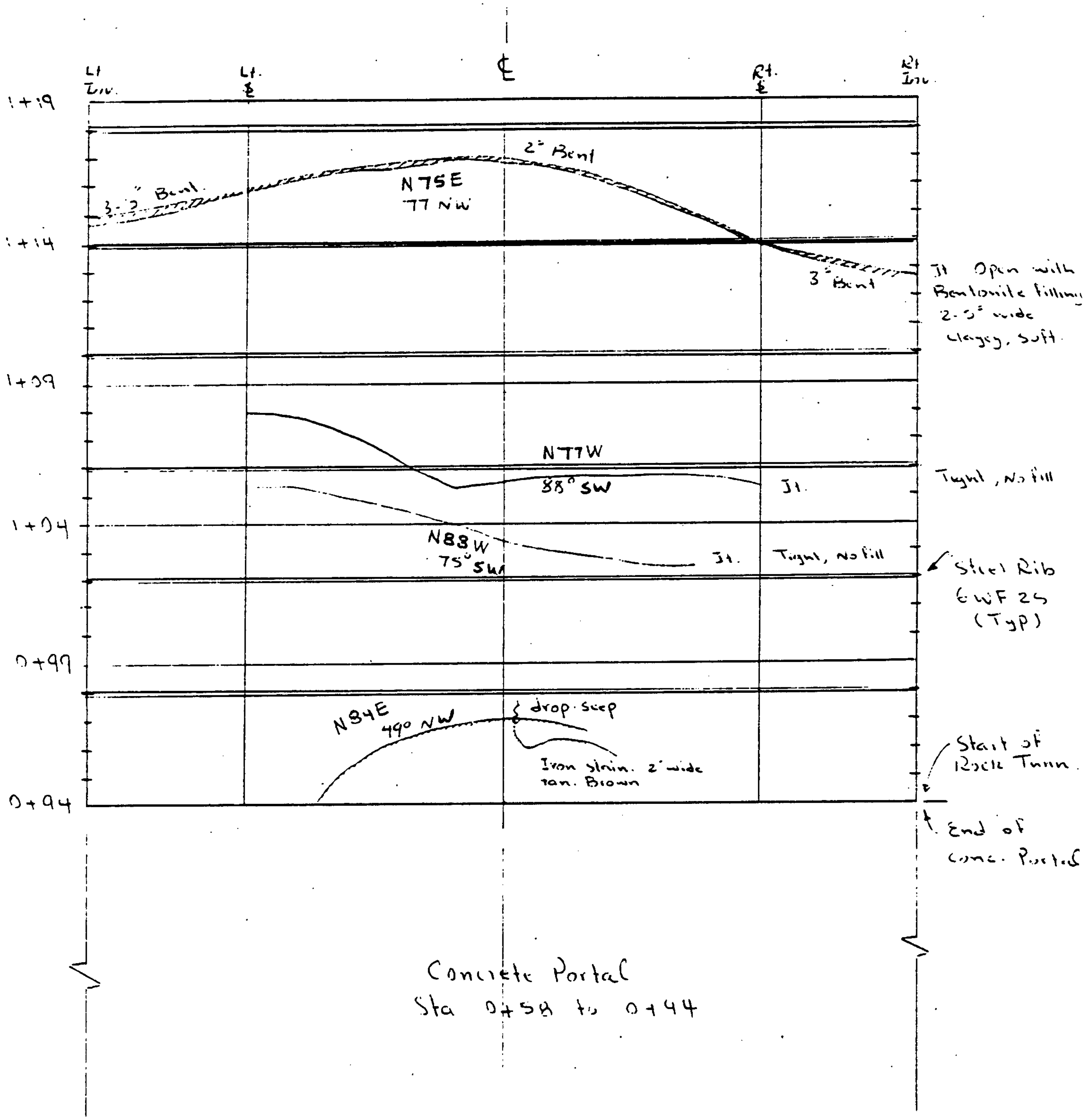
: Staining

: Filling Material

Job No. | No

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Task Rock : New Providence Shale	Sheet 2	Of 72



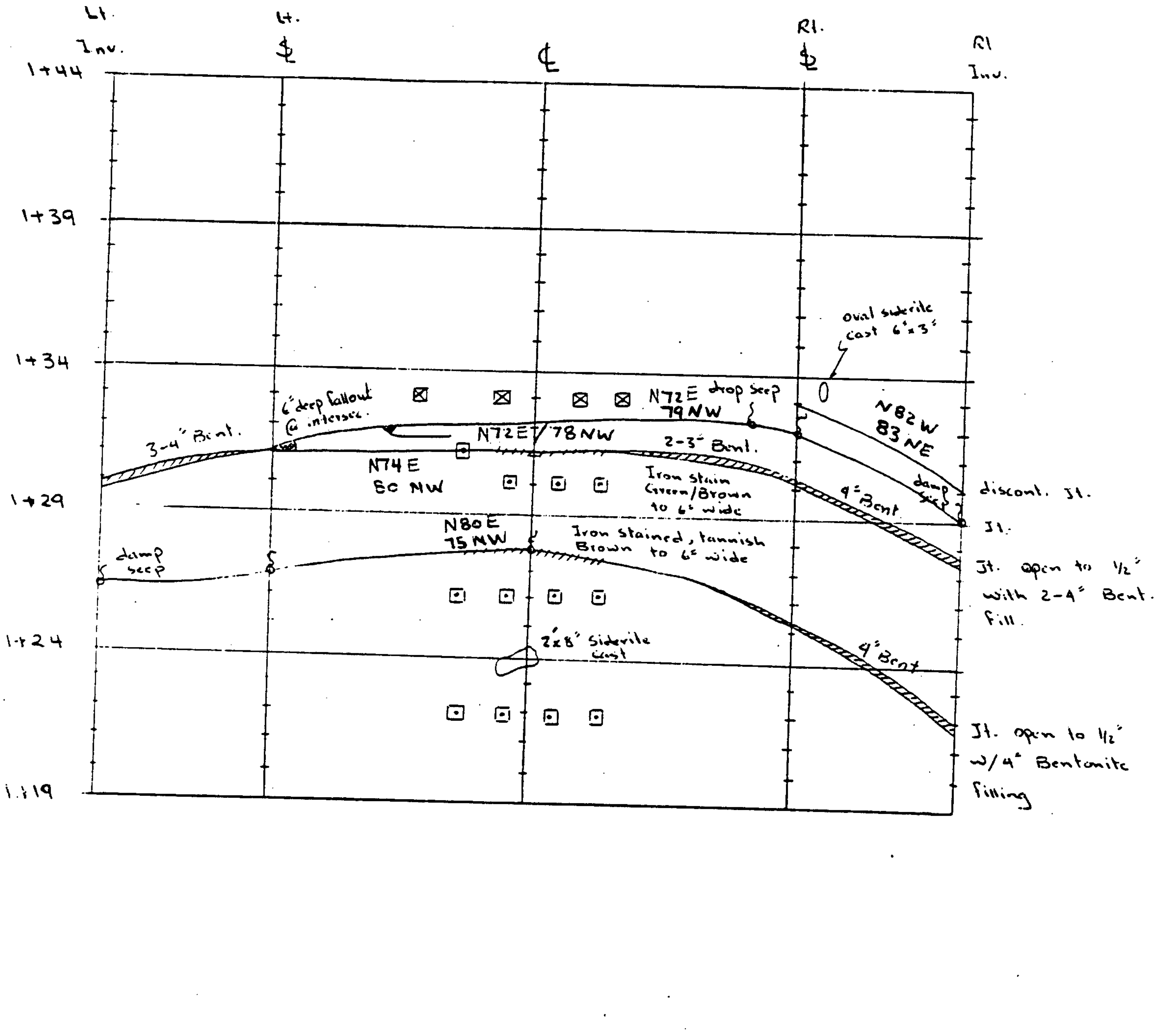
Job No. | No

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP | Computed | Date

Subject Geologic Mapping | Checked | Date

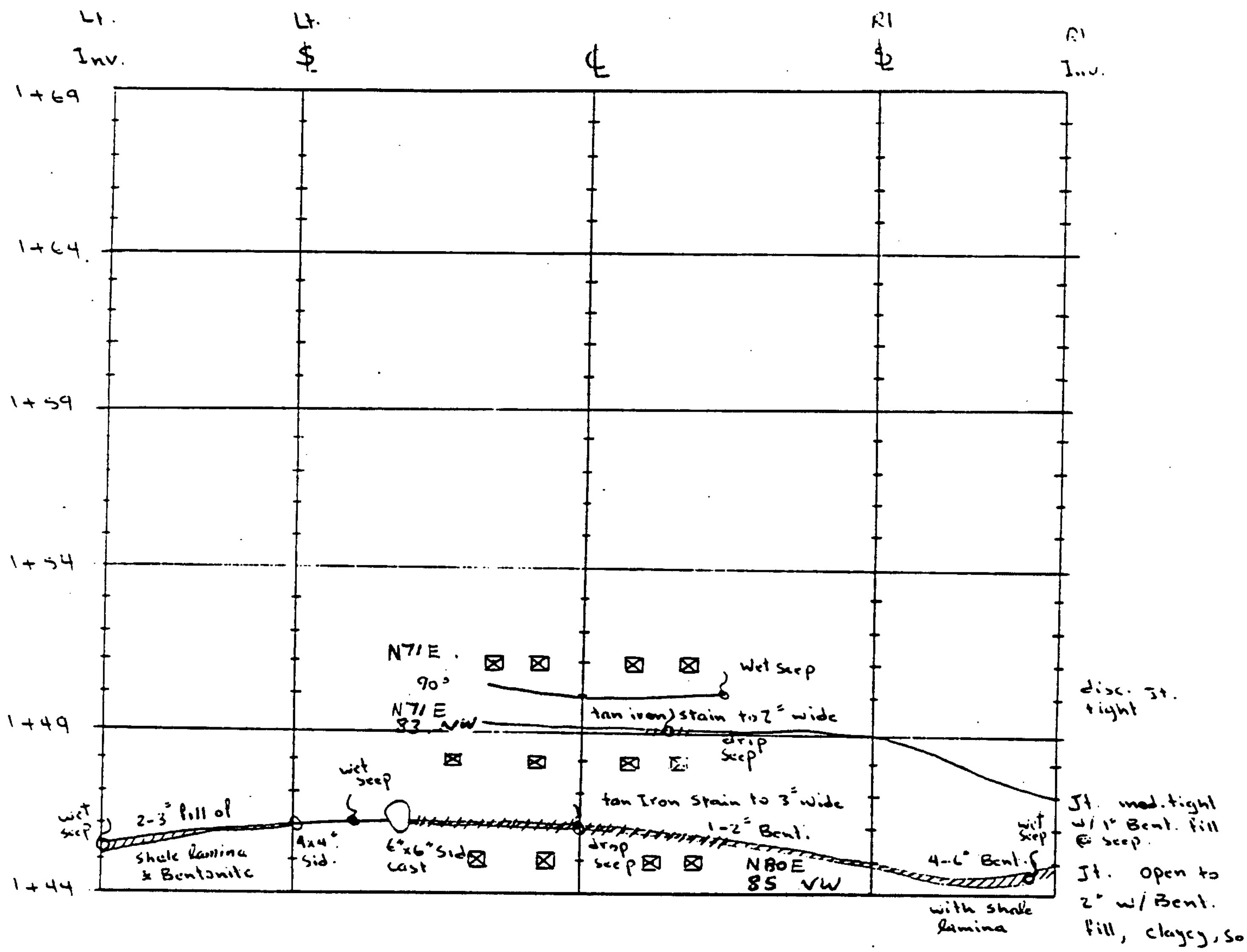
Task Rock : N.P. Shale | Sheet 3 | of 72



Job No. | No

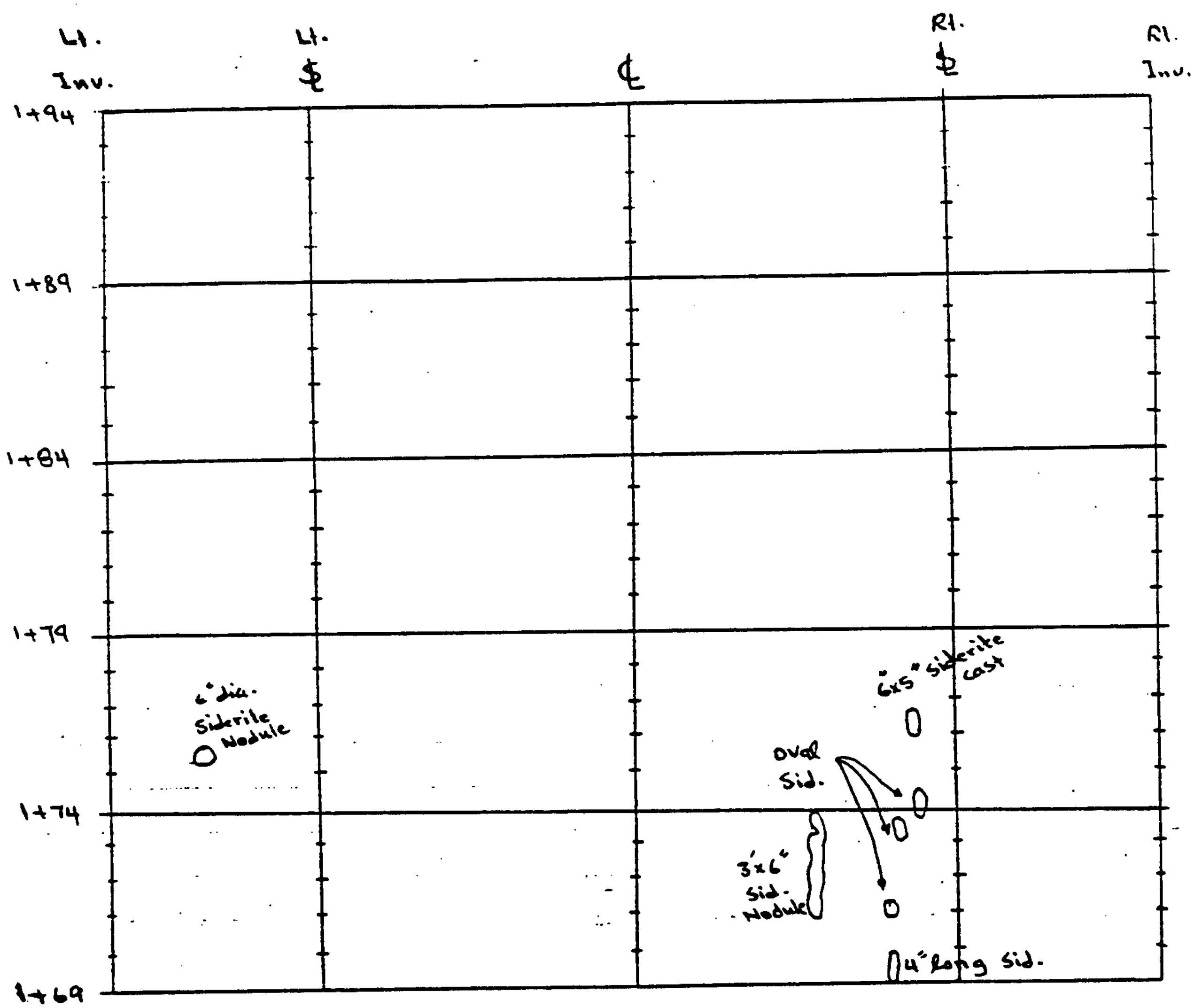
LACHEL & Associates, Inc.
Geologists, Engineers

Project: UTP		Computed	Date
Subject: Geologic Mapping		Checked	Date
Task: Rock: New Providence Shale		Sheet 4	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

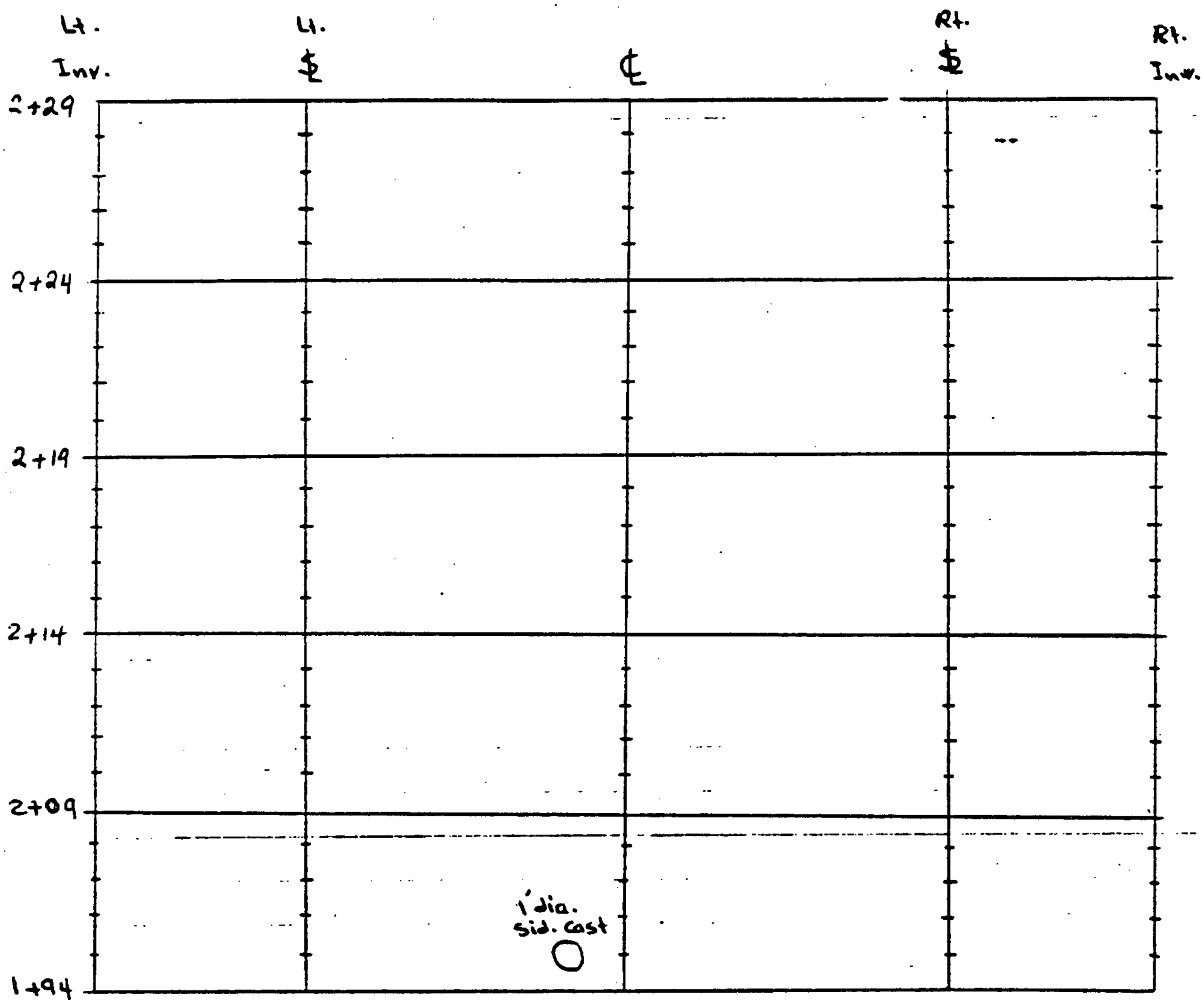
Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock : N. P. Shale	Sheet 5	Of 72



Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP		Computed	Date
Subject Geologic Mapping		Checked	Date
Task Rock : New Providence Shale		Sheet 6	Of 72

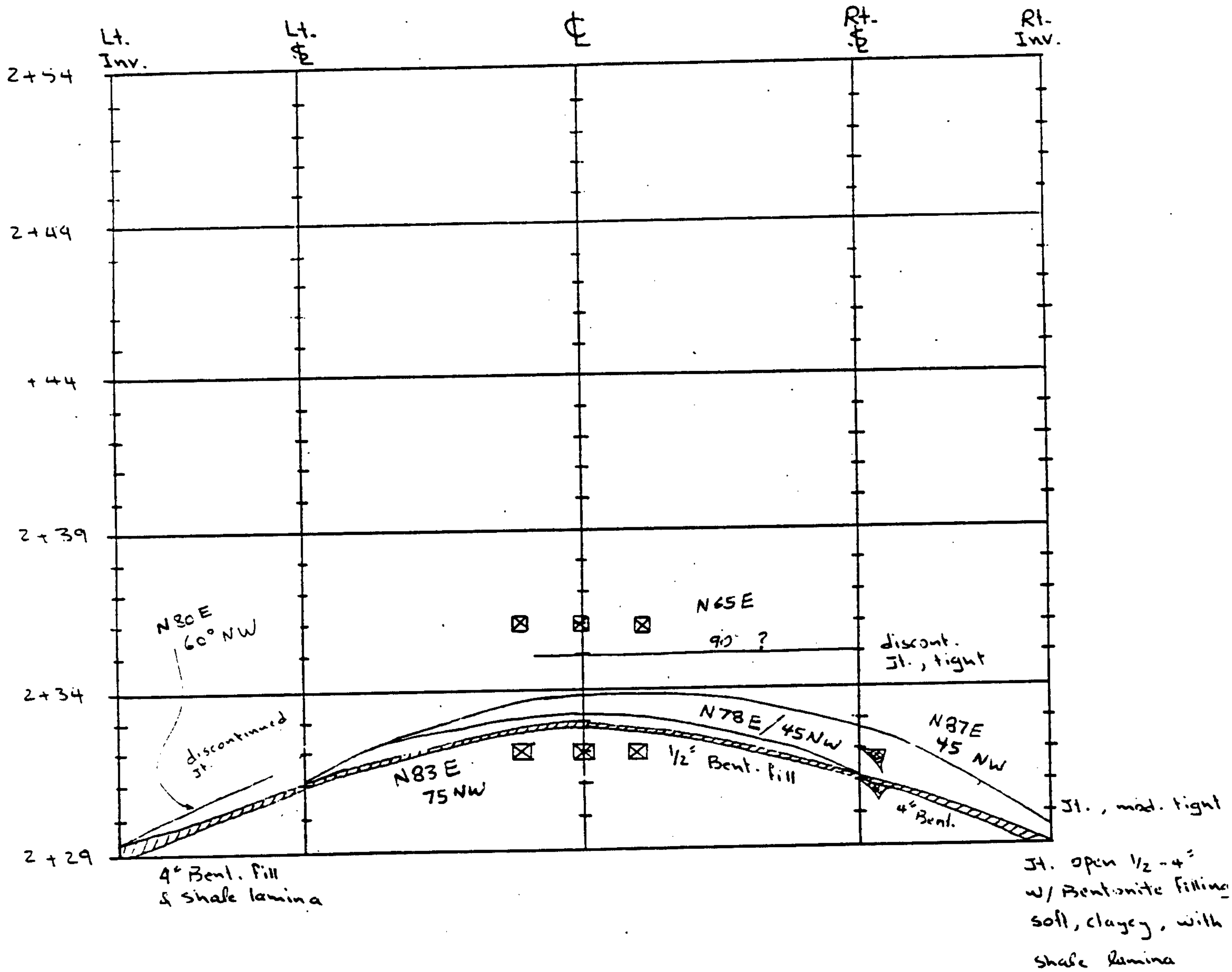


Massive Rock
No discontinuities

Job No. No

LACHEL & Associates, Inc.
Geologists, Engineers

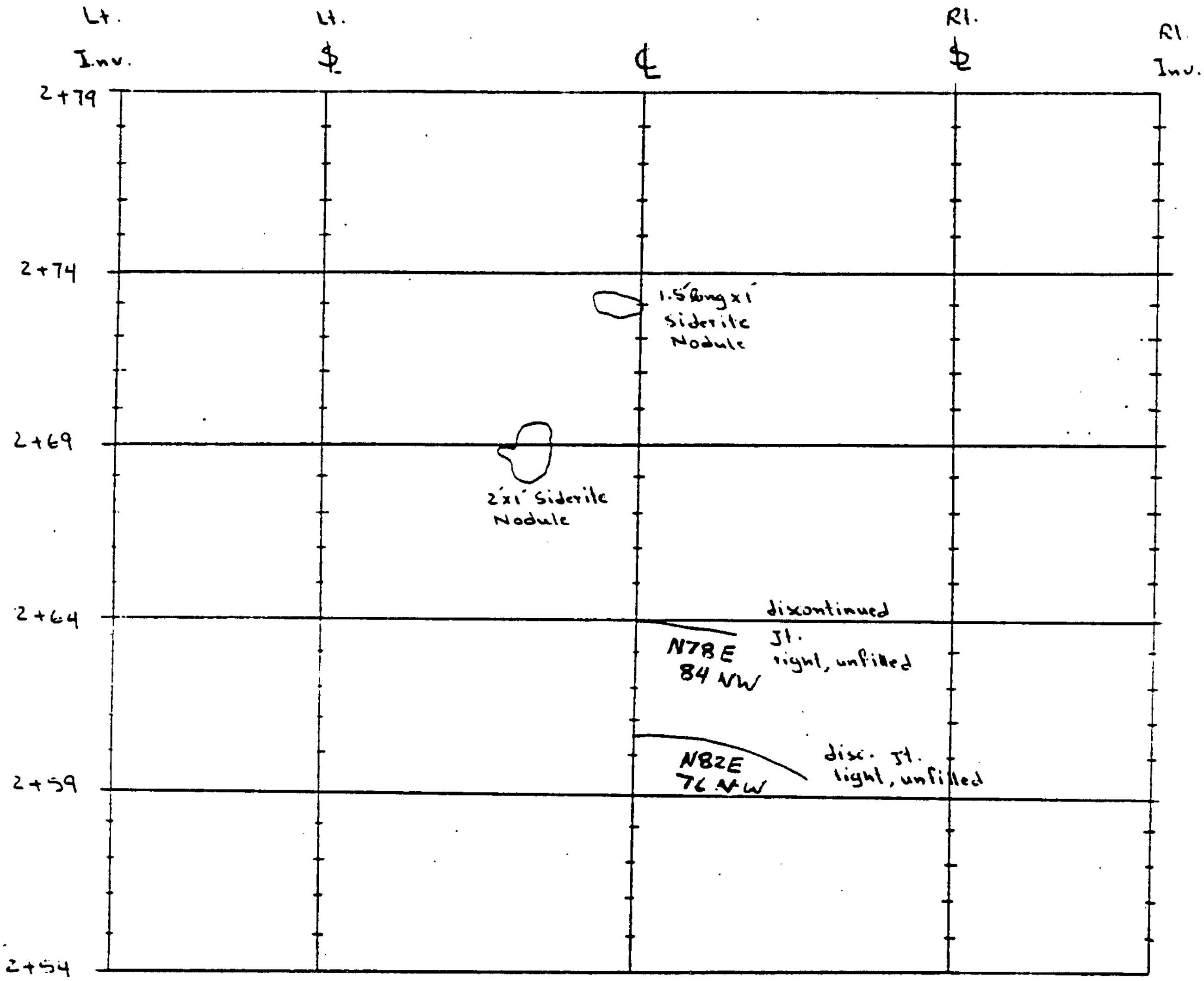
Project UTP		Computed	Date
Subject		Checked	Date
Task Rock: N.P. Shale		Sheet 7	Of 72



Job No. | No

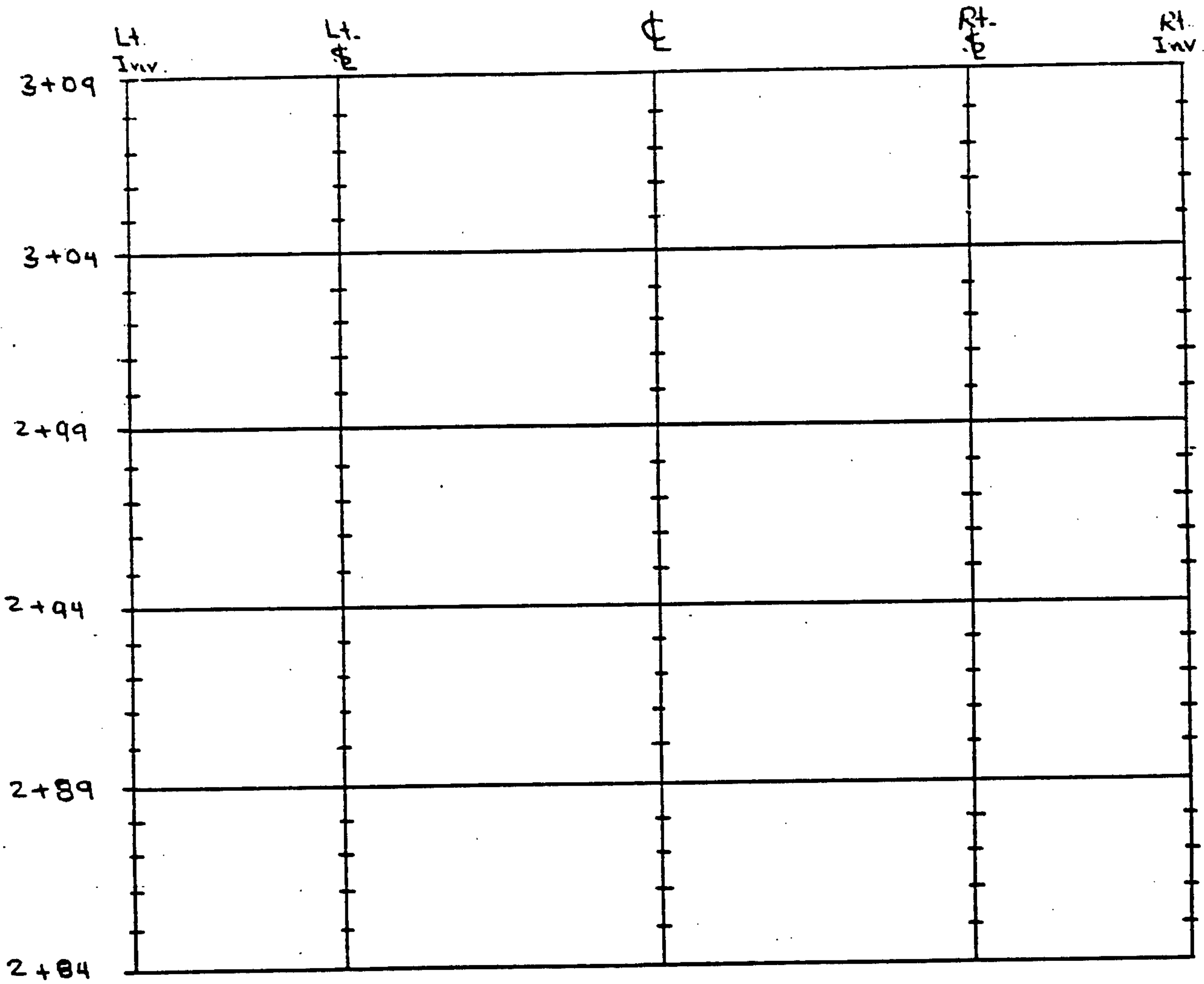
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : N.P. Shale	Sheet 8	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

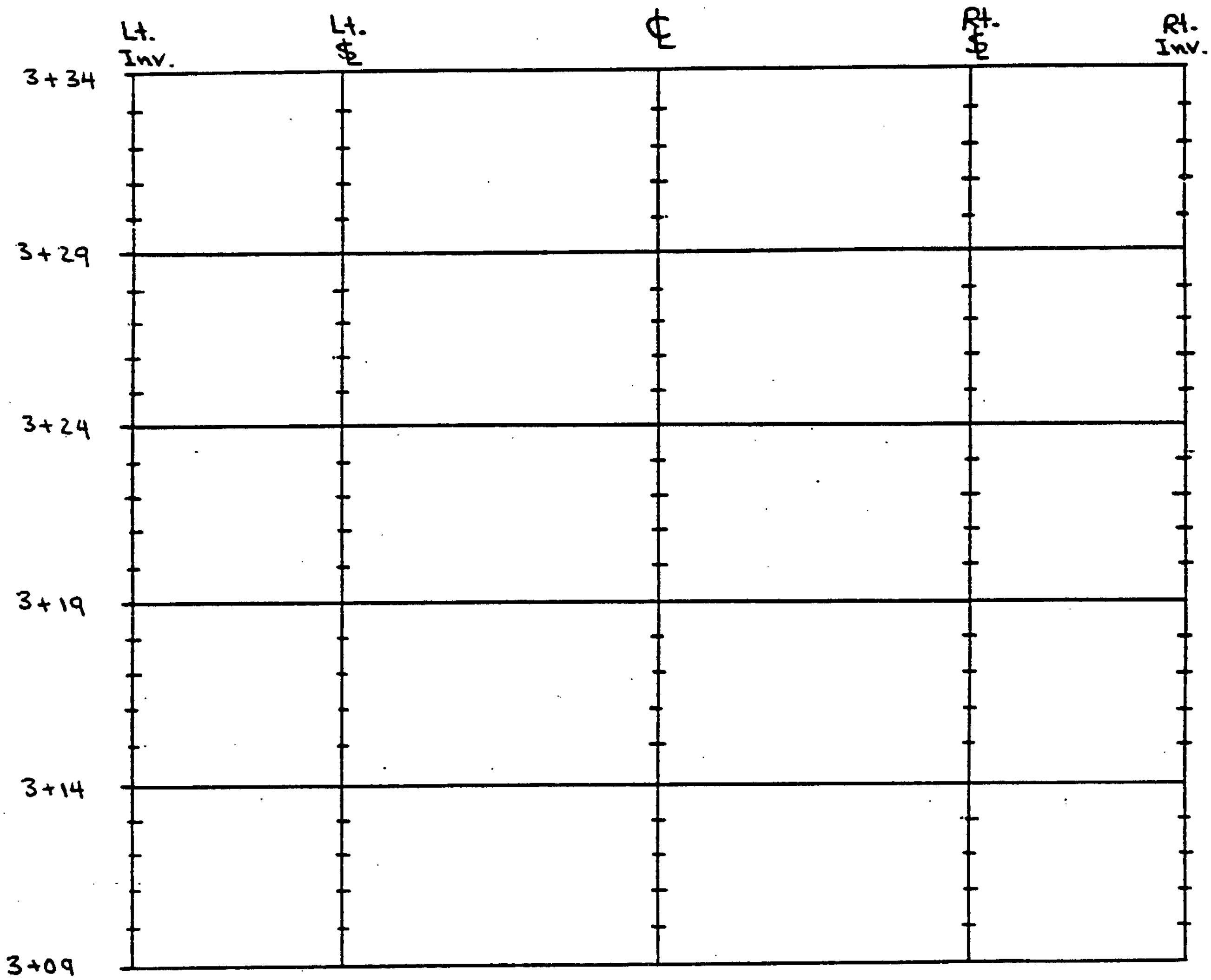
Project UTP		Computed	Date
Subject		Checked	Date
Task Rock : N. P. Shale		Sheet 9	Of 72



Massive Rock
No discontinuities

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence shale / ~~calcareous~~	Sheet 10	Of 72

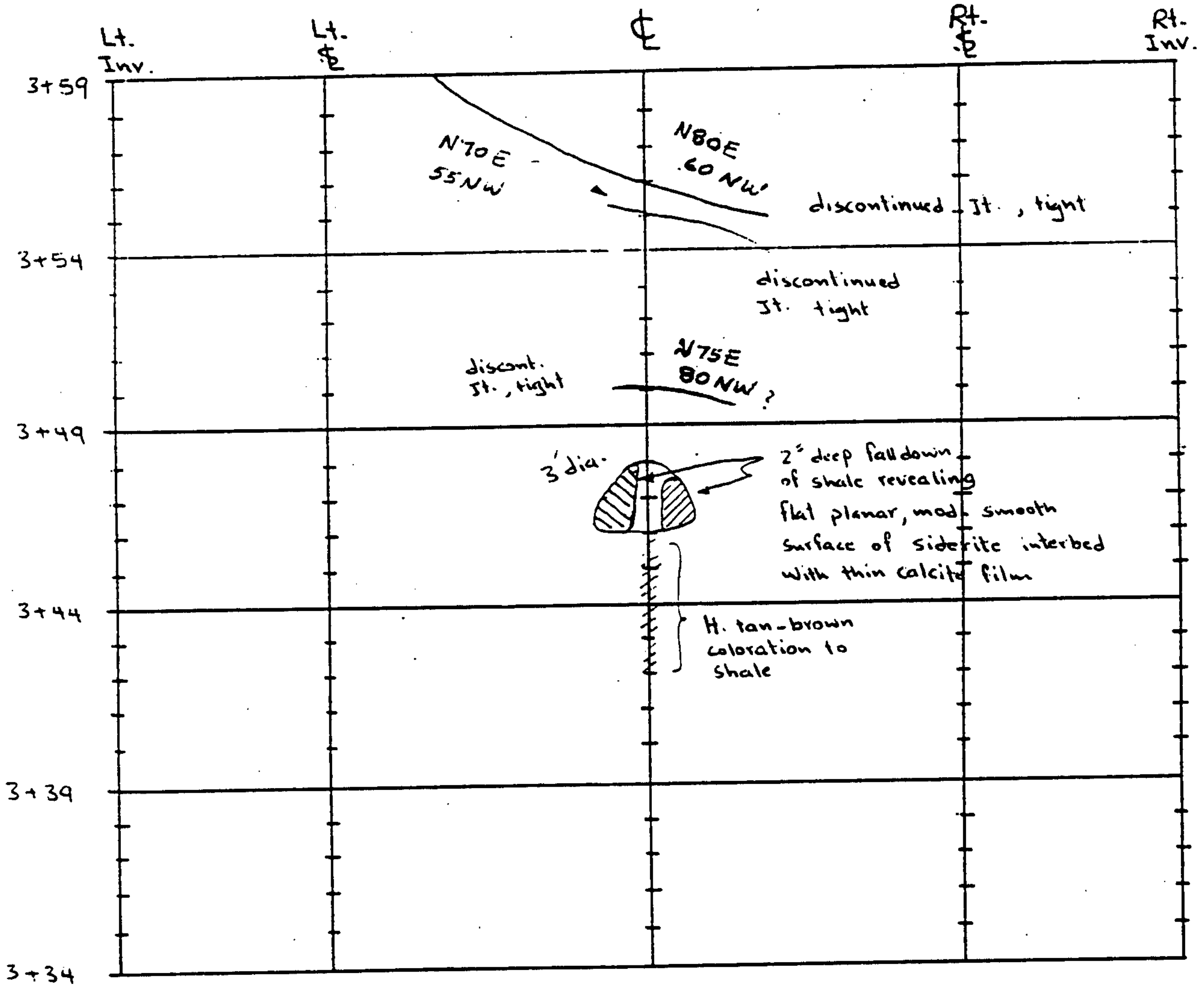


Massive New Providence shale formation with no discontin.

Job No.

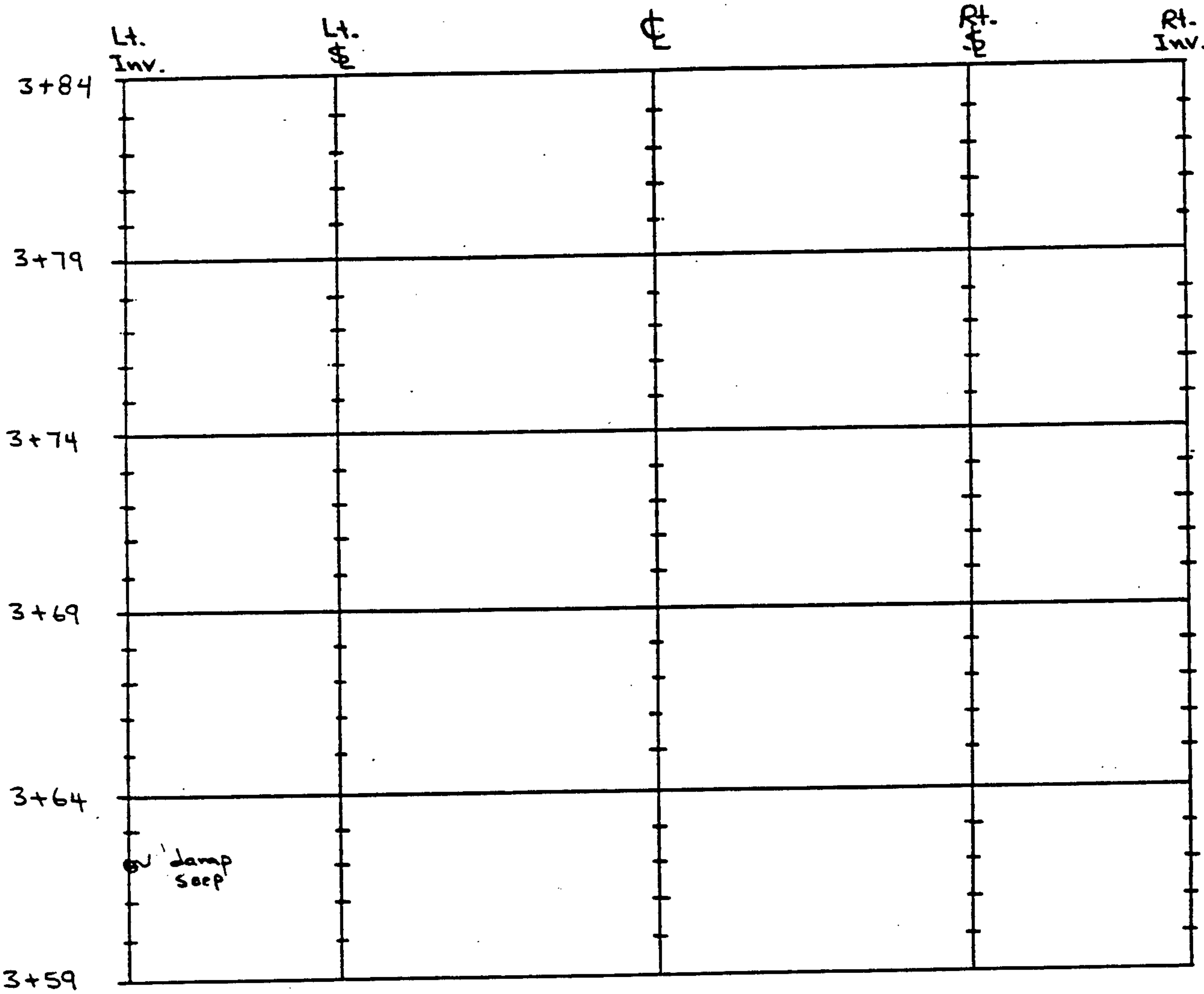
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale / ~~calcareous~~	Sheet 11	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence shale /	Sheet 12	Of 72



Massive Rock w/ no joints

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Geologists, Engineers

Project UTP		Computed	Date
Subject		Checked	Date
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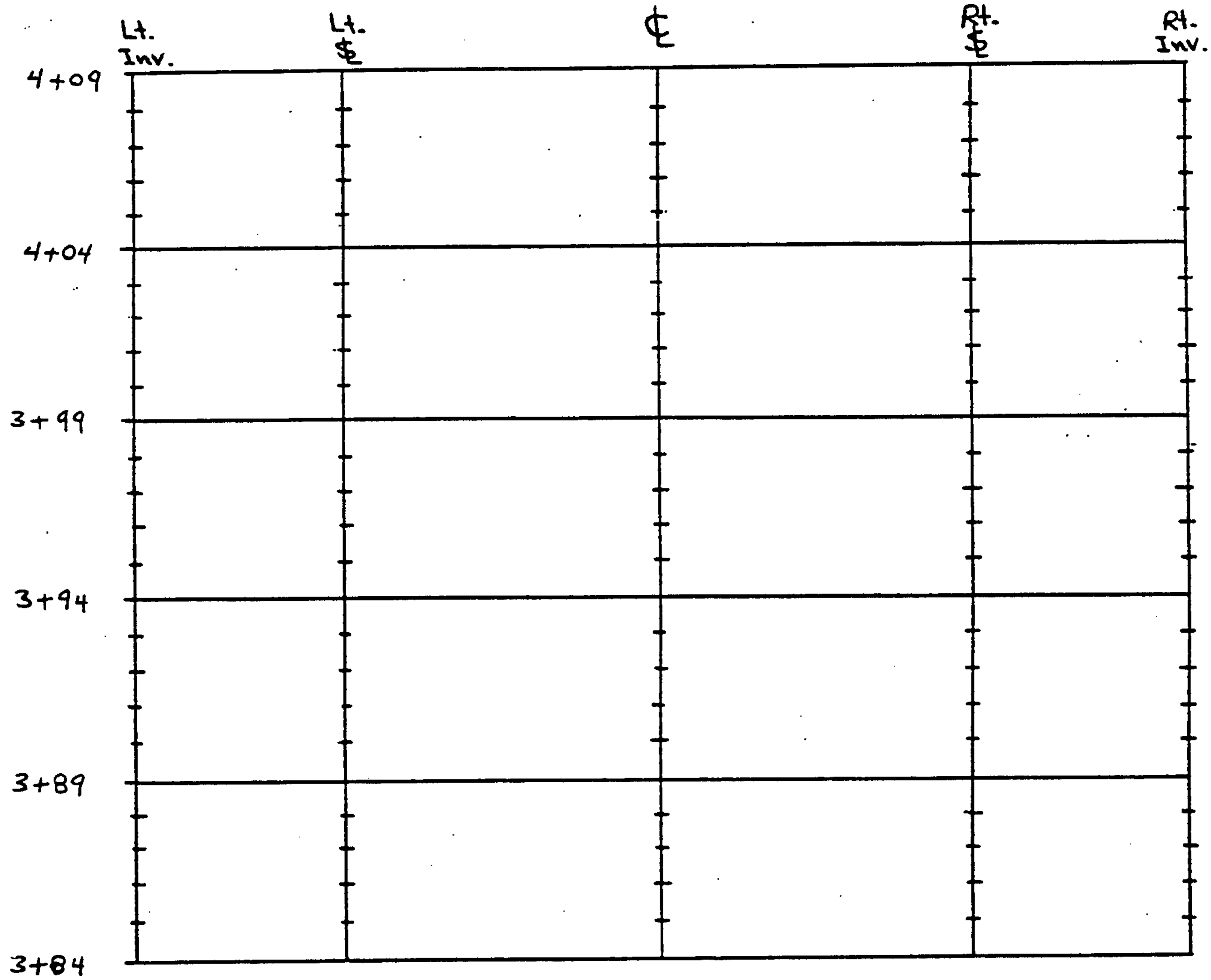

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date	
Subject	Checked	Date	
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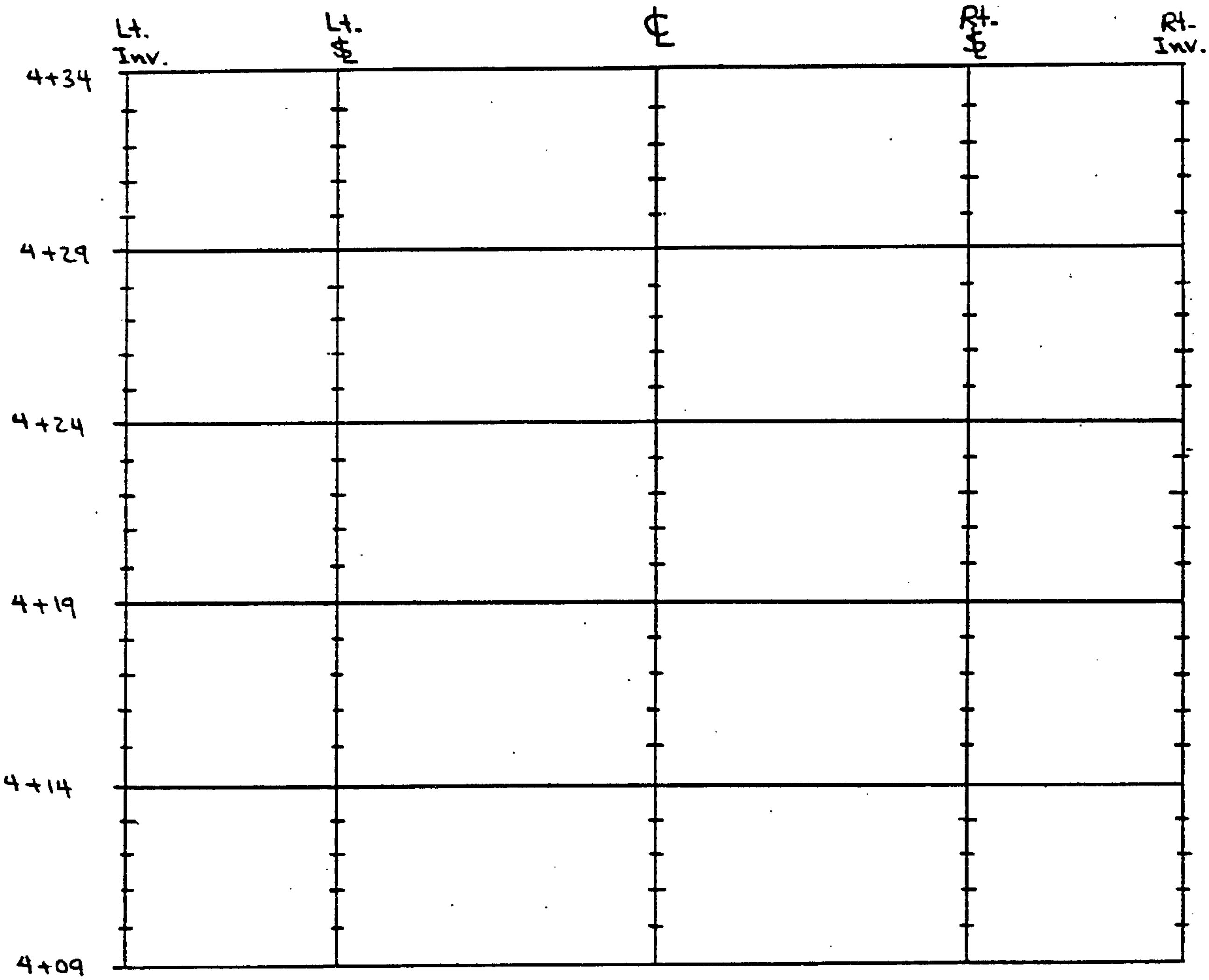
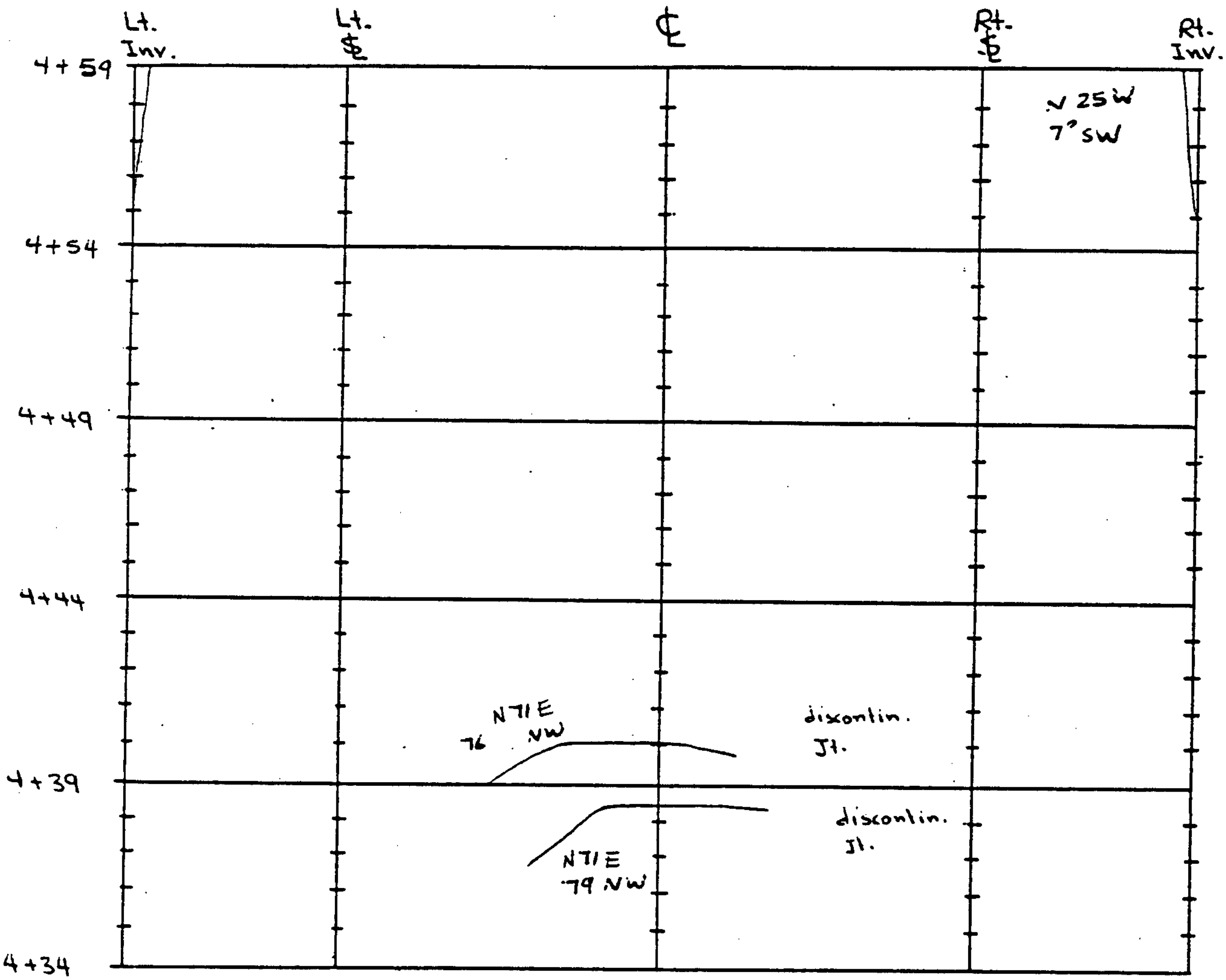


Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP | Computed | Date
Subject | Checked | Date
Task Rock : New Providence Shale / | Sheet 15 | Of 72



Bedding plane on both walls, tight with 2-4" thick lamination along it

both are tight w/no filling or staining most possibly are stress releife

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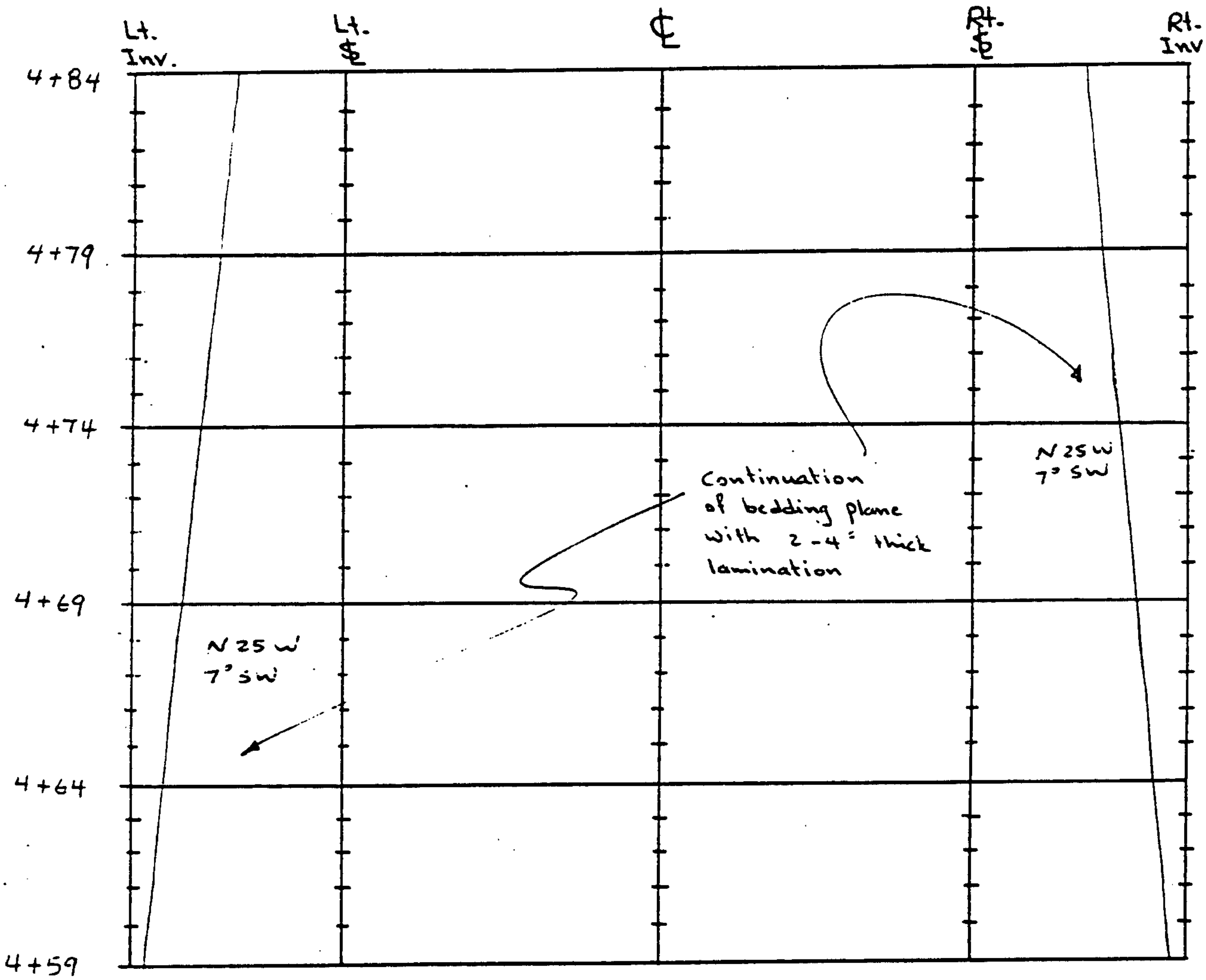
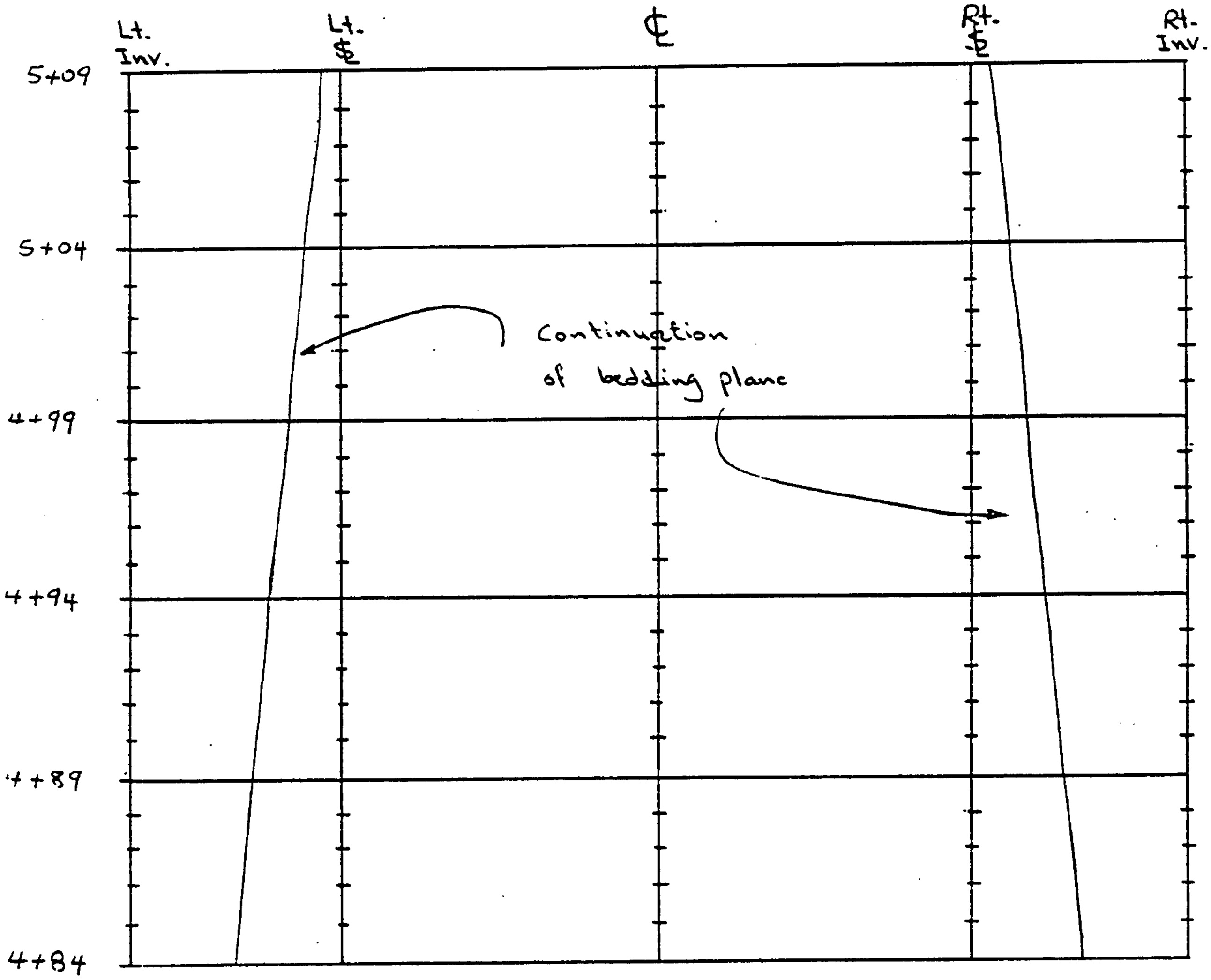
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale / ~~arkansas~~	Sheet 16	Of 72



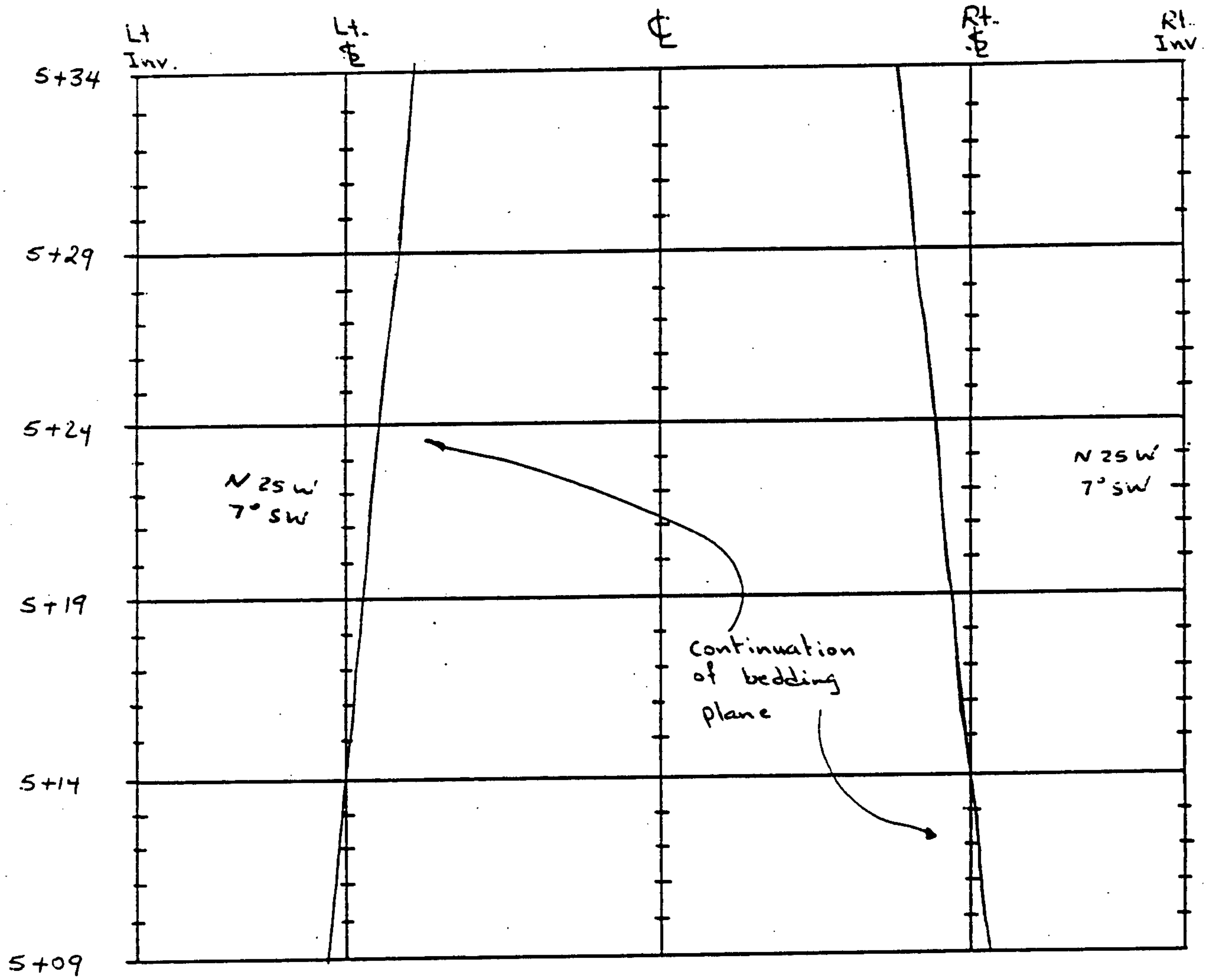
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale / ~~Calcareous~~	Sheet 17	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Task Rock : New Providence shale / ~~calcareous~~	Sheet 18	Of 72



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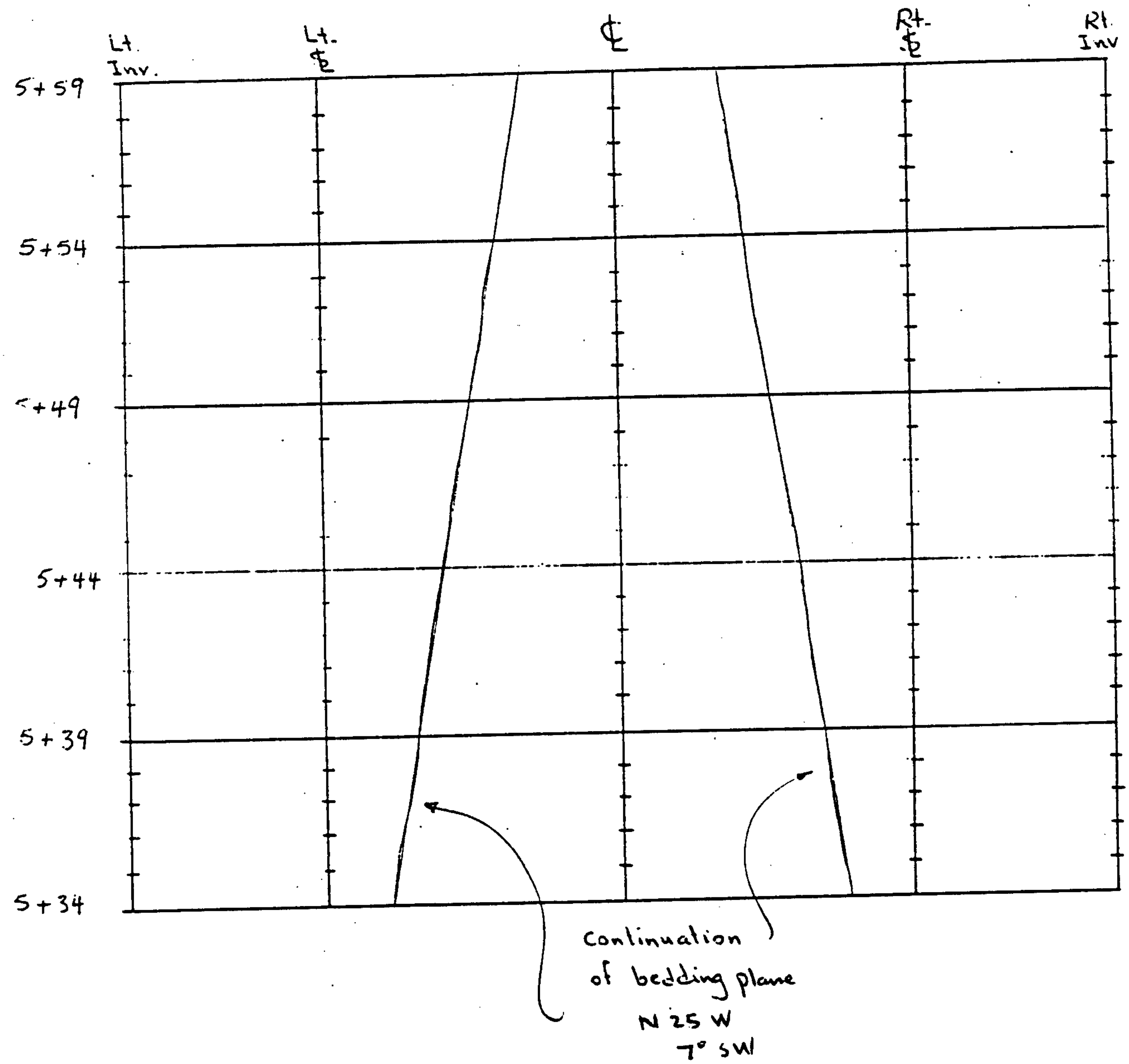
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
~~Task~~	Rock : New Providence shale / ~~calcareous~~	Sheet 19	of 72



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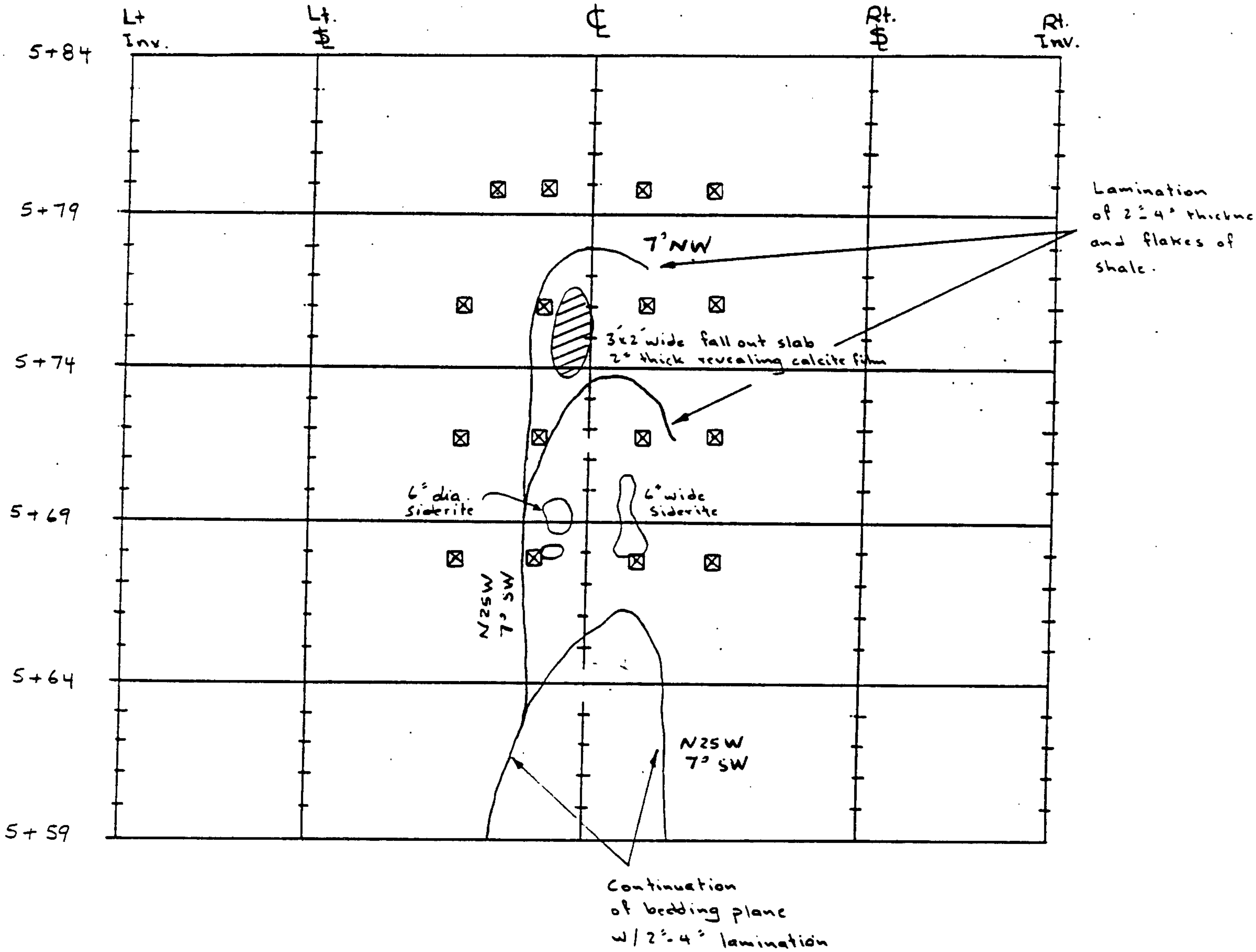
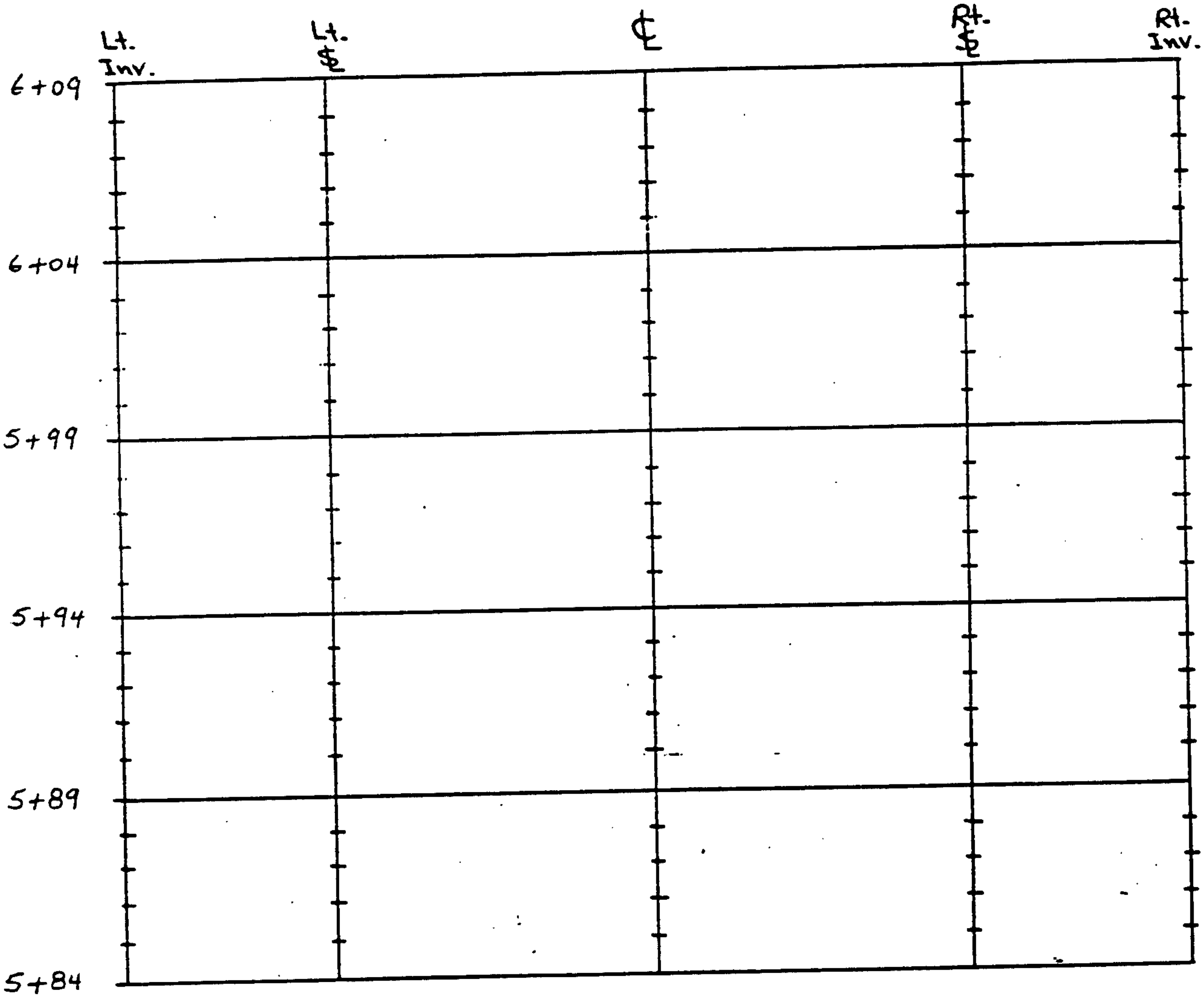
Geologists, Engineers

Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Task Rock : New Providence Shale	Sheet 20	Of 71



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Task Rock : New Providence Shale /	Sheet 21	Of 72



Massive Rock
w/ no Joints

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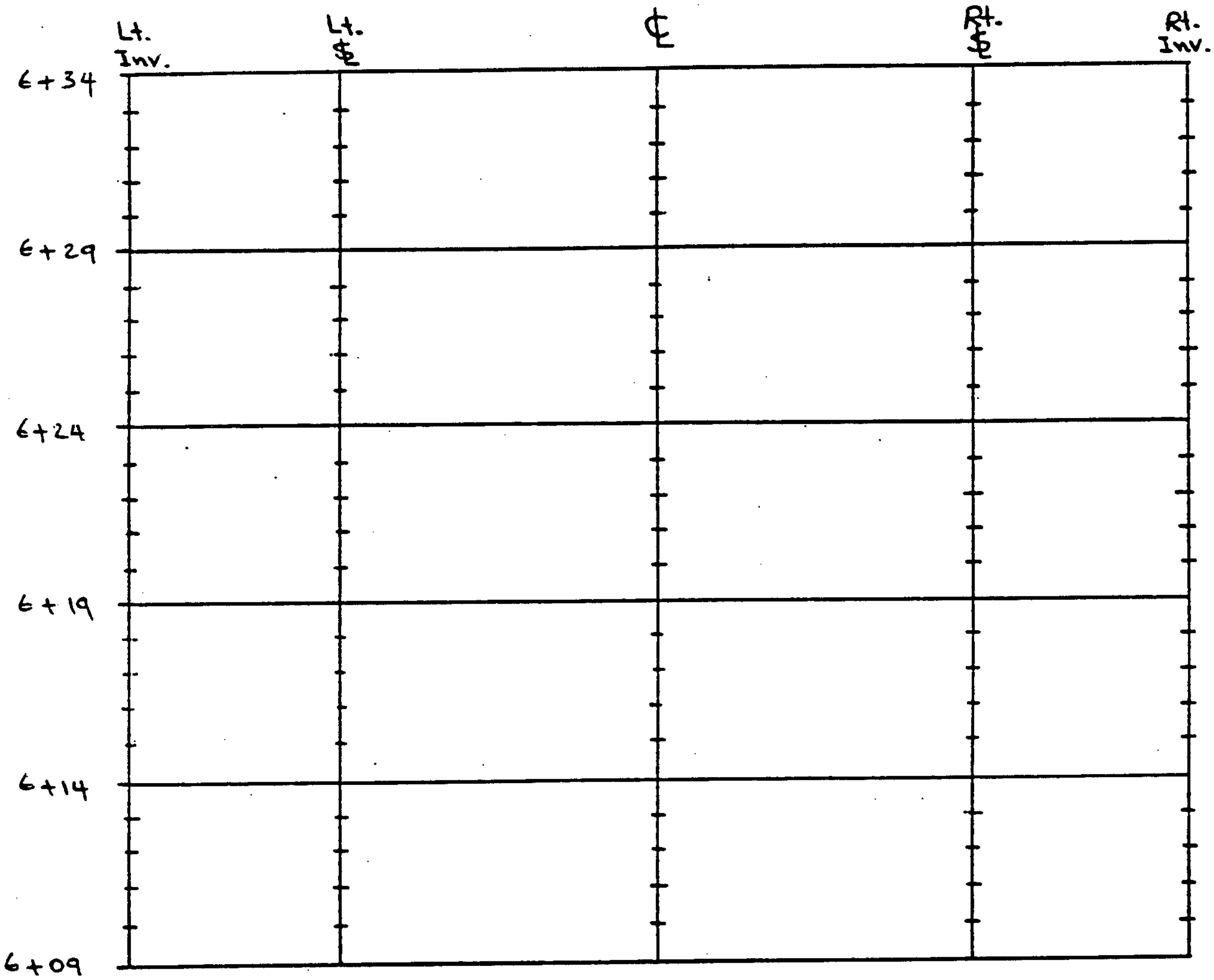
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale / ~~calcareous~~	Sheet 22	Of 72



Massive Rock
No discontinuities

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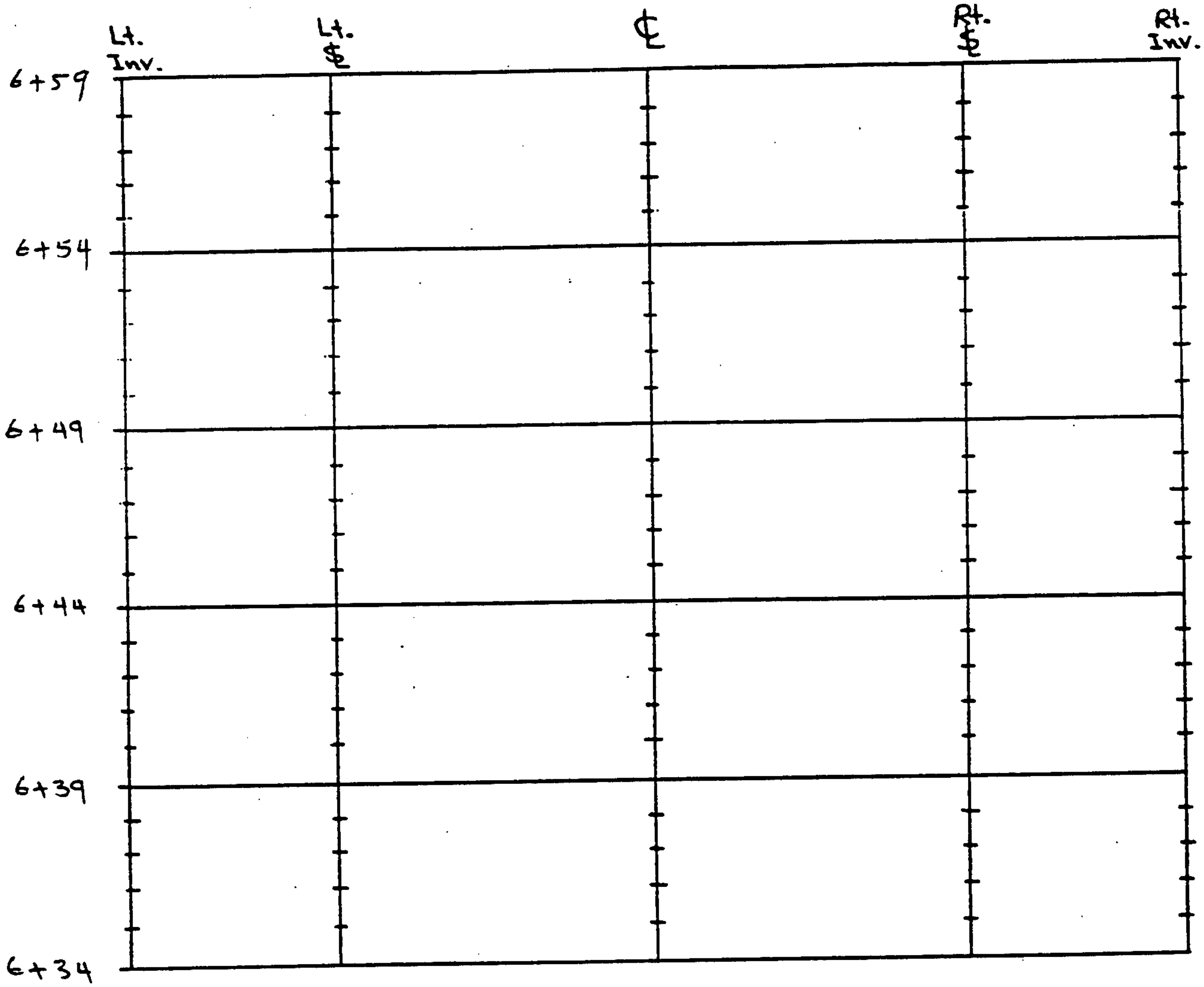
Geologists, Engineers

Project UTP		Computed	Date
Subject		Checked	Date
~~Task~~ Rock : New Providence Shale / ~~calcareous~~		Sheet 23	Of 72



Massive Rock
No Joints

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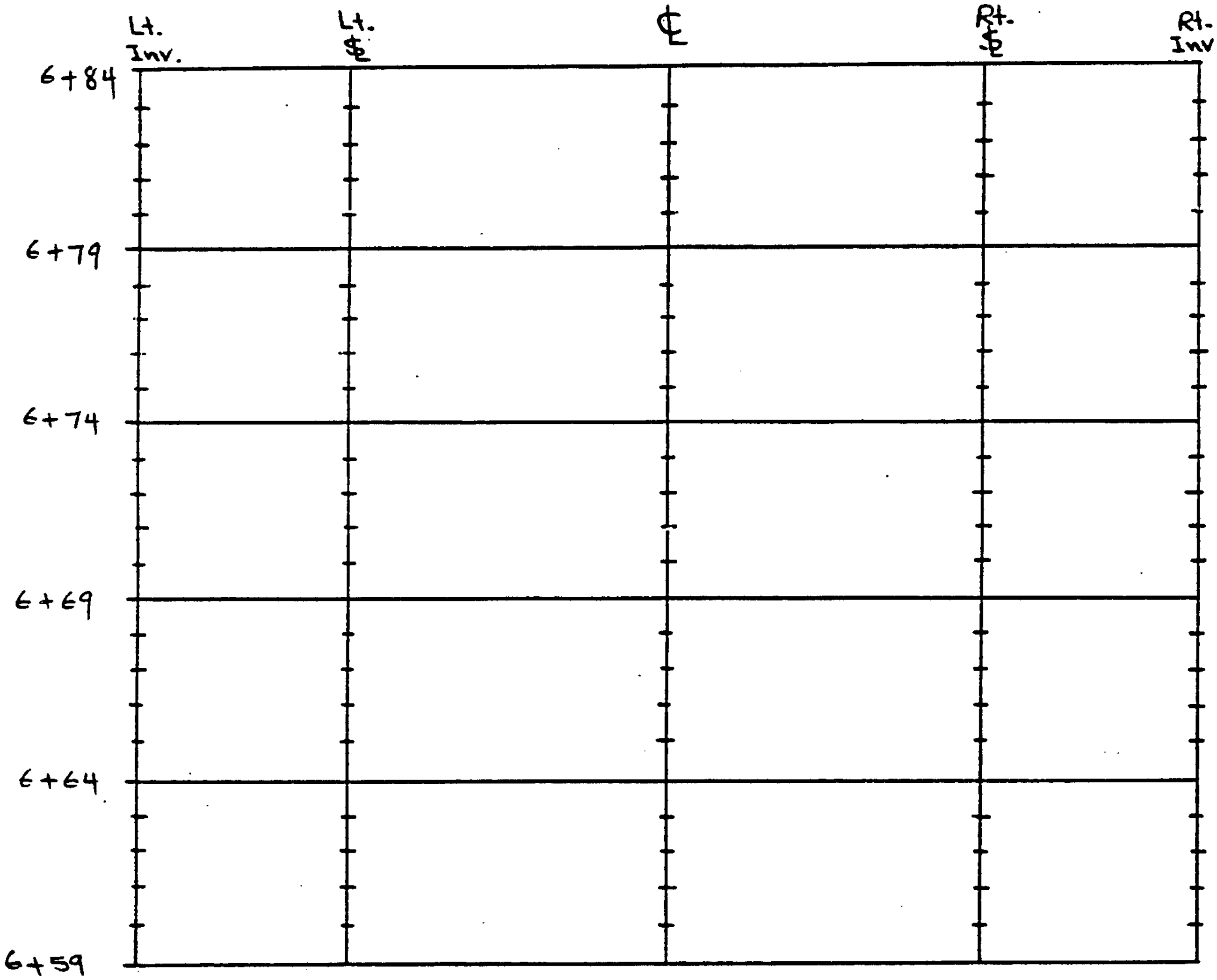
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
~~Task~~ Rock : New Providence Shale / ~~calcareous~~	Sheet 24	of 72



Massive Rock
No Joints

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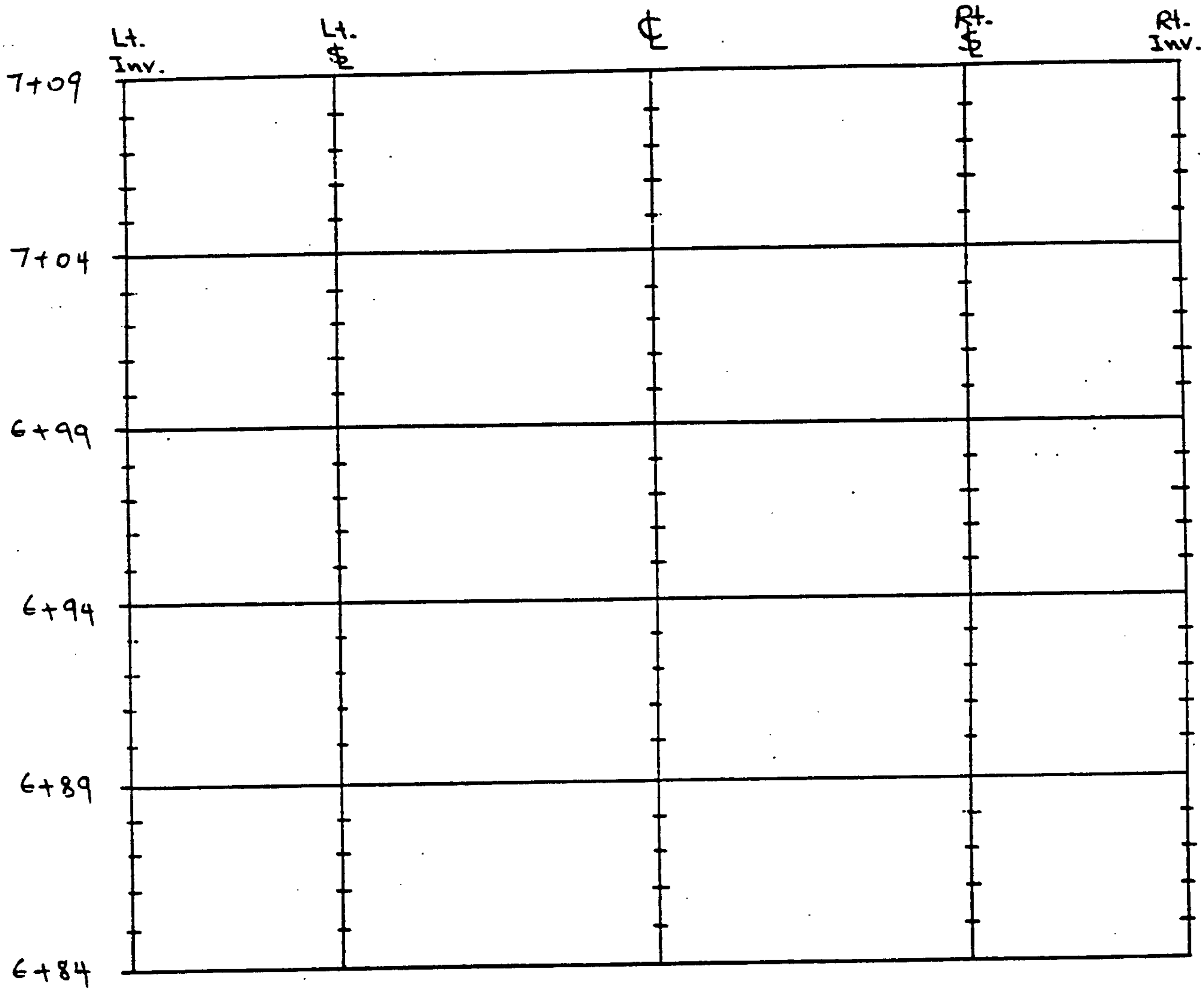
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task New Providence Shale / ~~Calcareous~~	Sheet 25	Of 72



Massive Rock
No Joints

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Project UTP	Computed	Date
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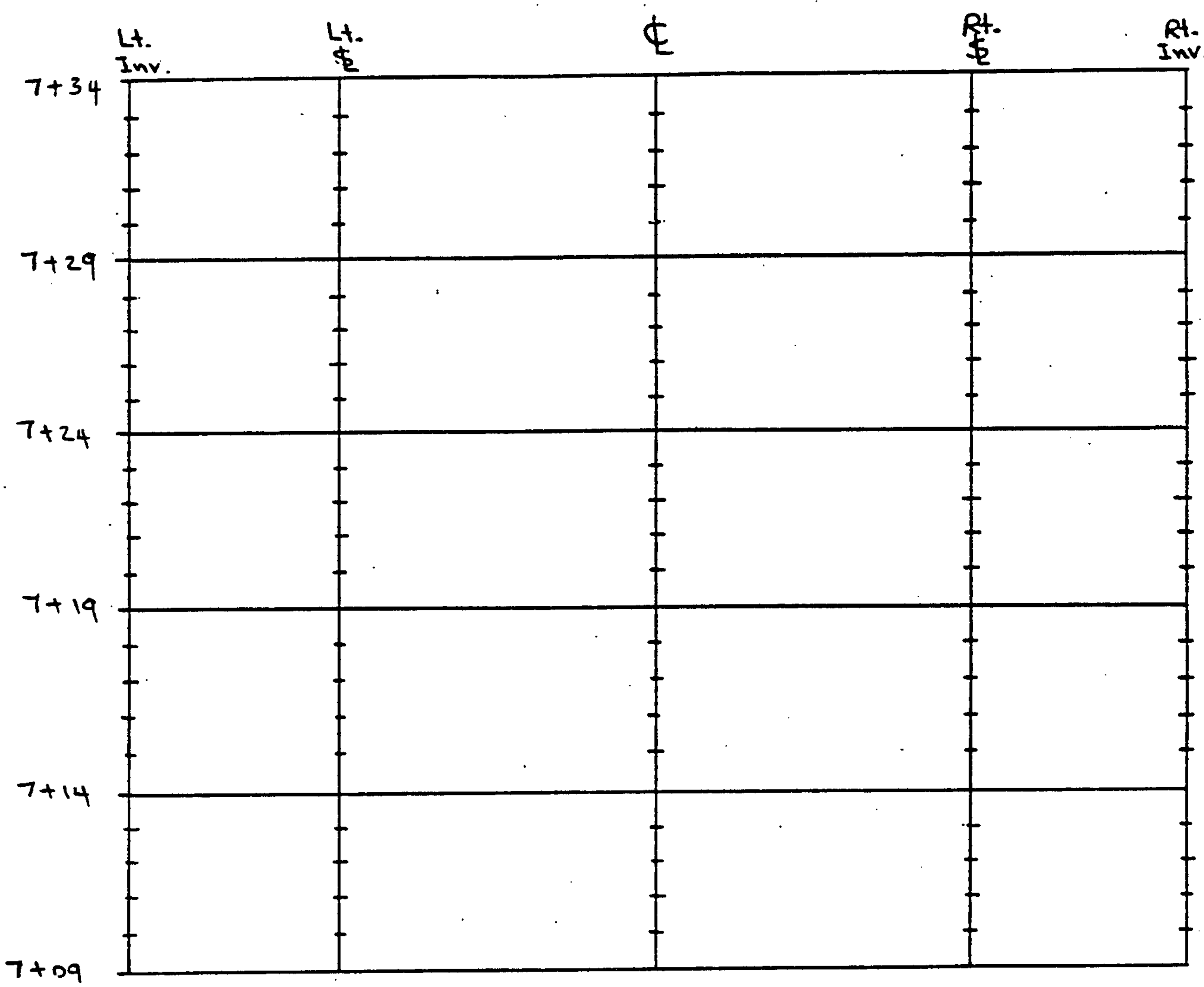
Task Rock: New Providence shale /	Sheet 26	Of 72

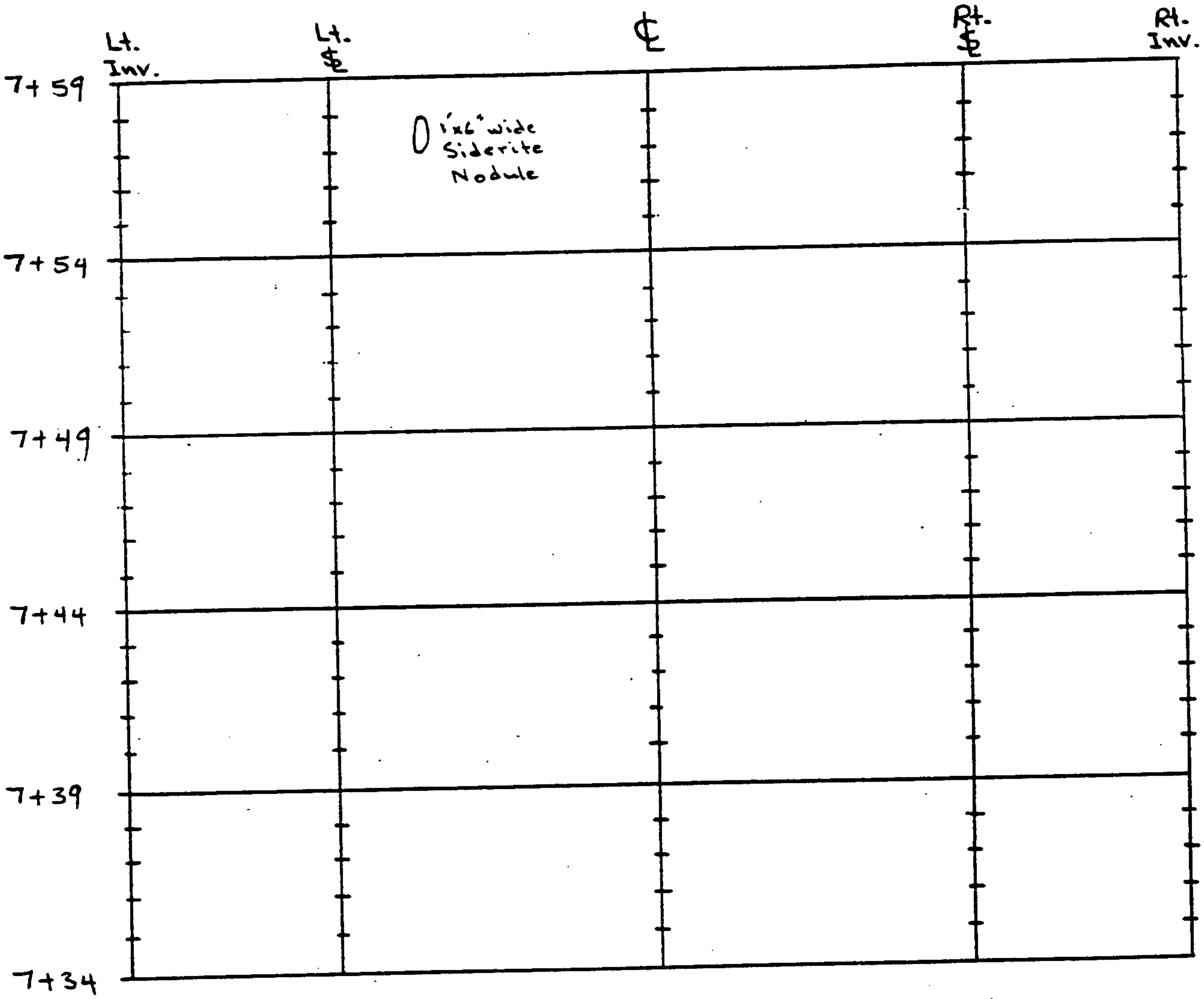


Massive Rock

No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale /	Sheet 27	of 72



Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
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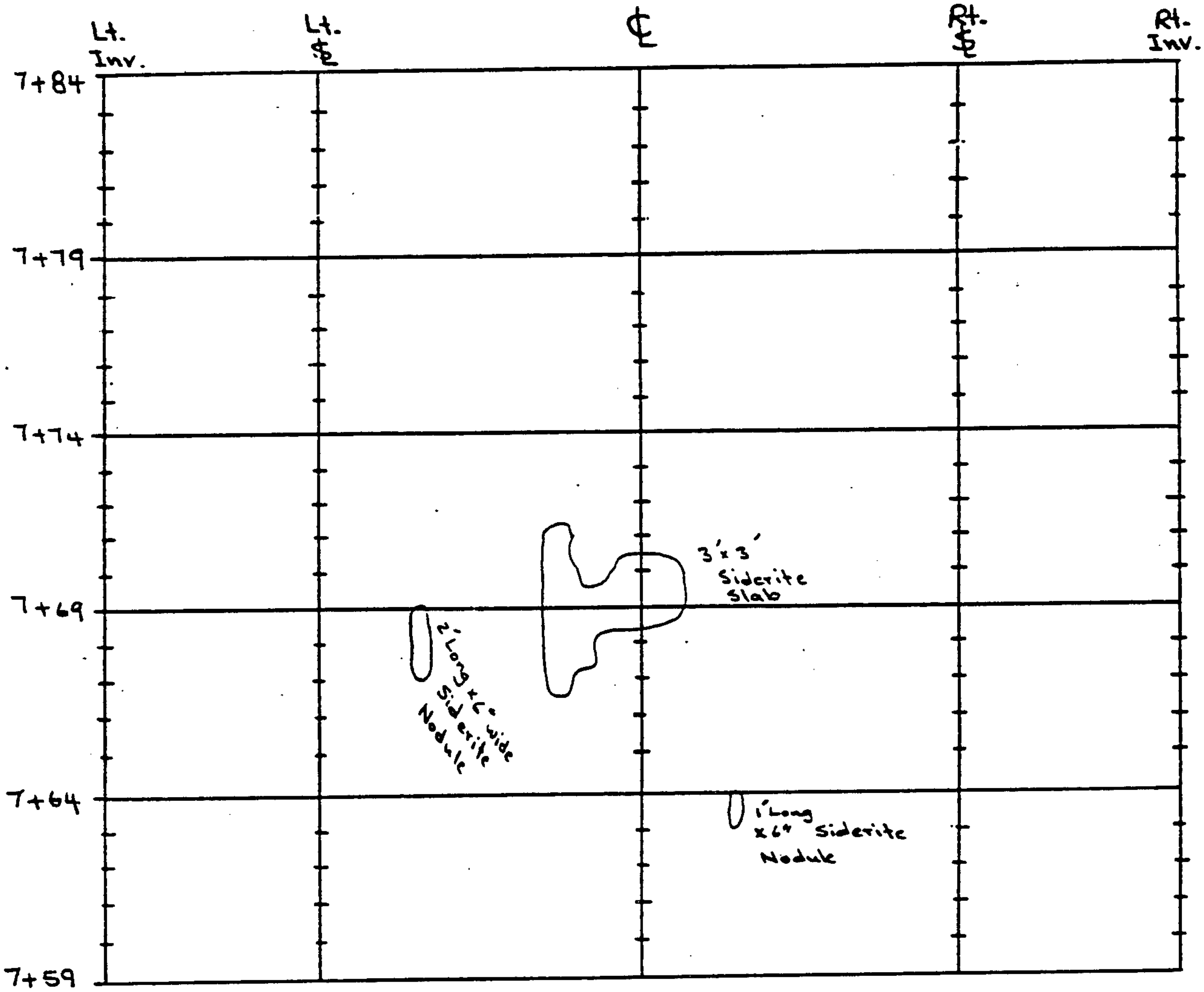
Task Rock: New Providence Shale	Sheet 28	Of 72



Massive Rock

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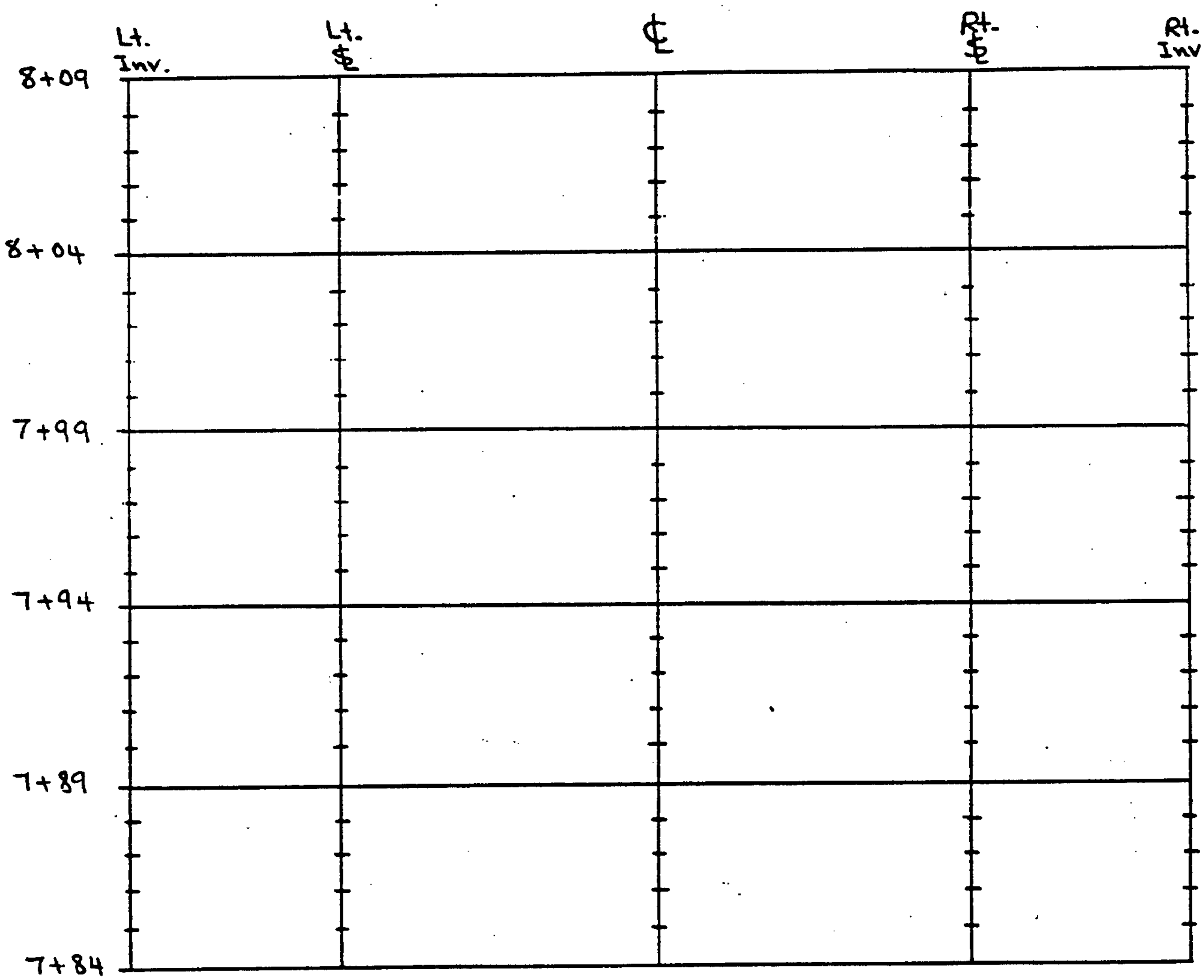
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence shale	Sheet 29	Of 72



Massive Rock

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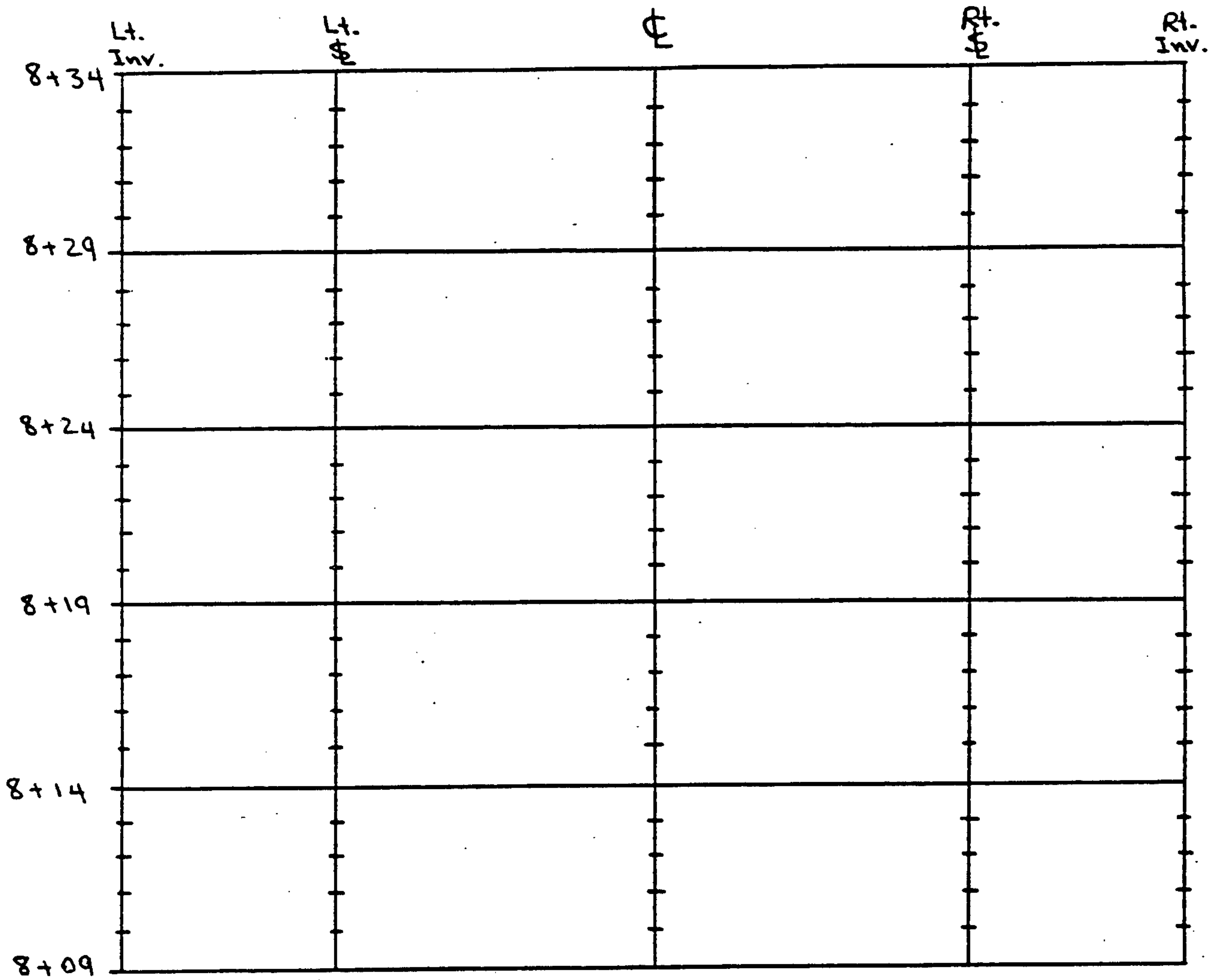
Geologists, Engineers

Project	UTP	Computed		Date	
Subject		Checked		Date	
Task	Rock: New Providence Shale	Sheet	30	Of	72



Massive Rock

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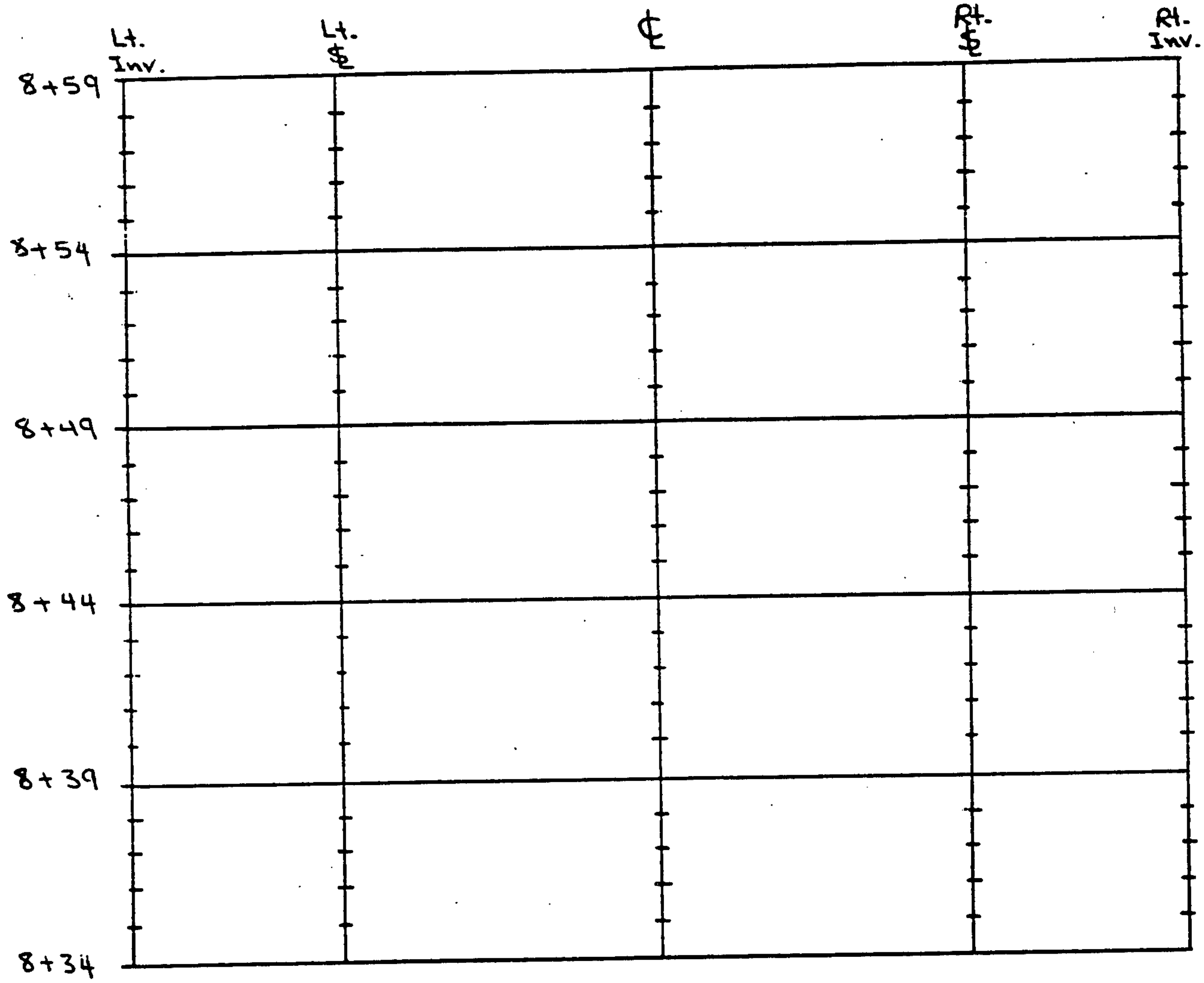
Geologists, Engineers

Project UTP | Computed | Date
Subject | Checked | Date
Task Rock: New Providence shale | Sheet 31 | Of 72



Massive Rock

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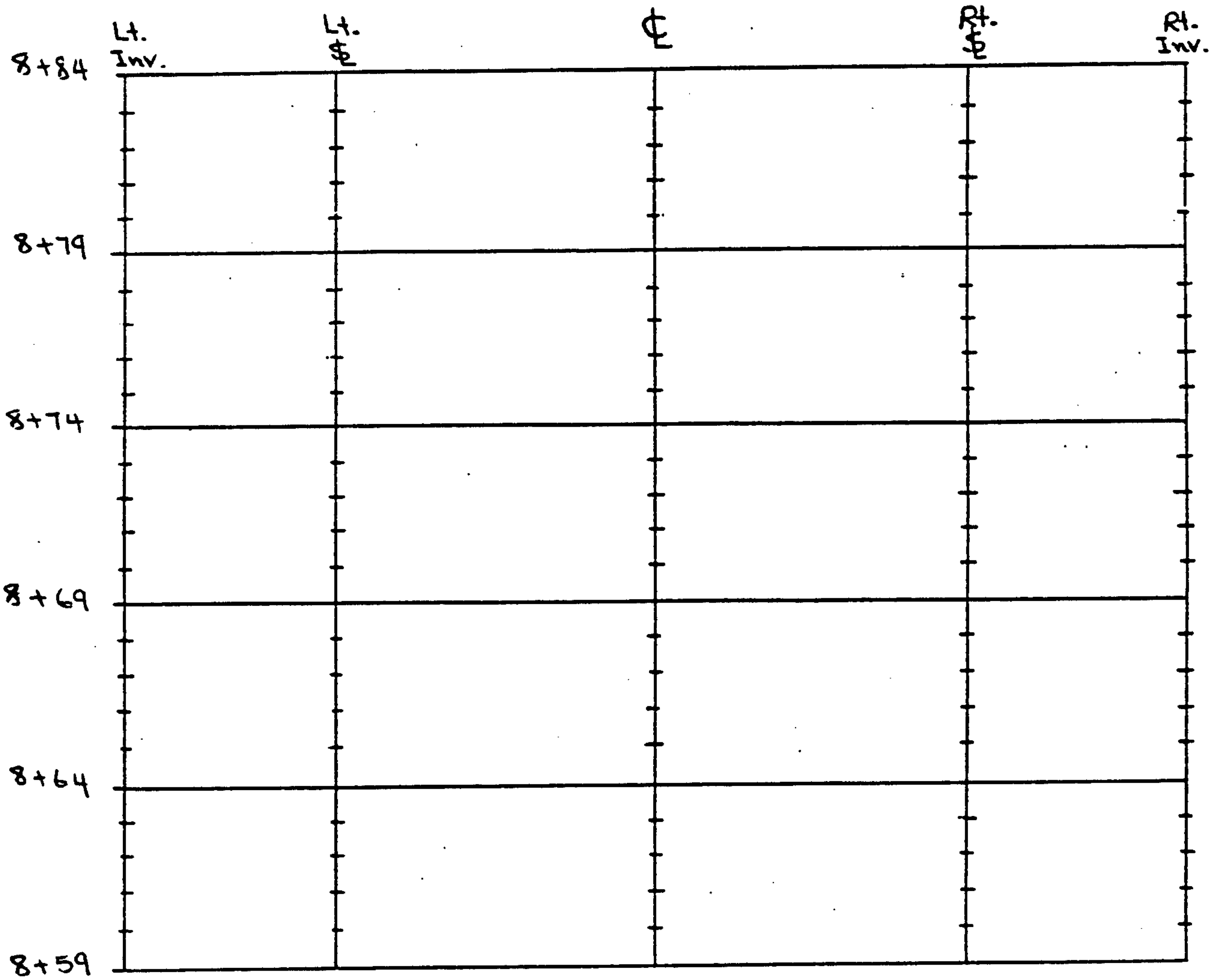
Geologists, Engineers

Project UTP		Computed	Date
Subject		Checked	Date
Task Rock: New Providence shale		Sheet 32	Of 72



Massive Rock

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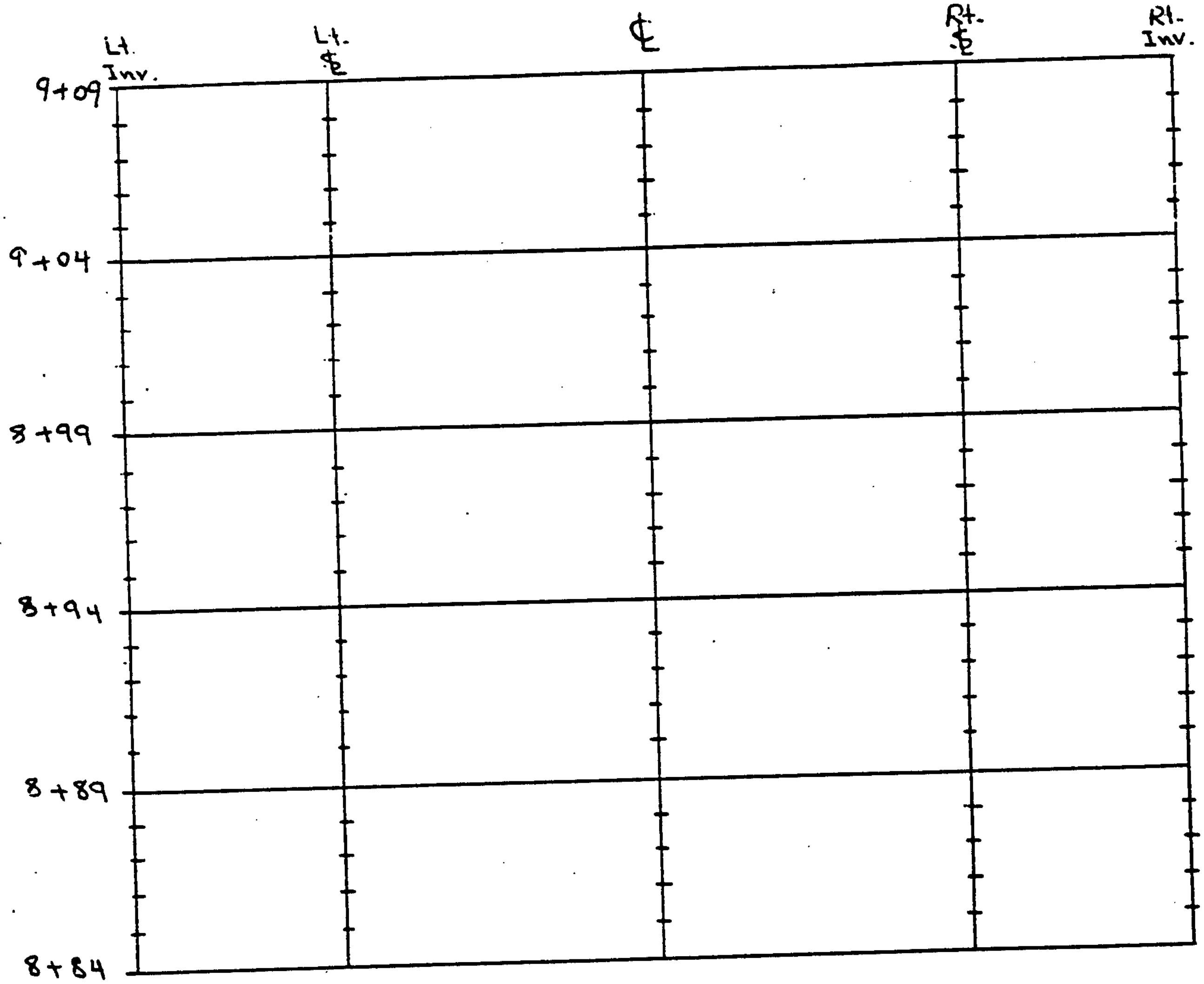
Geologists, Engineers

Project UTP		Computed	Date
Subject		Checked	Date
Task Rock : New Providence shale		Sheet 33	Of 72



Massive Rock

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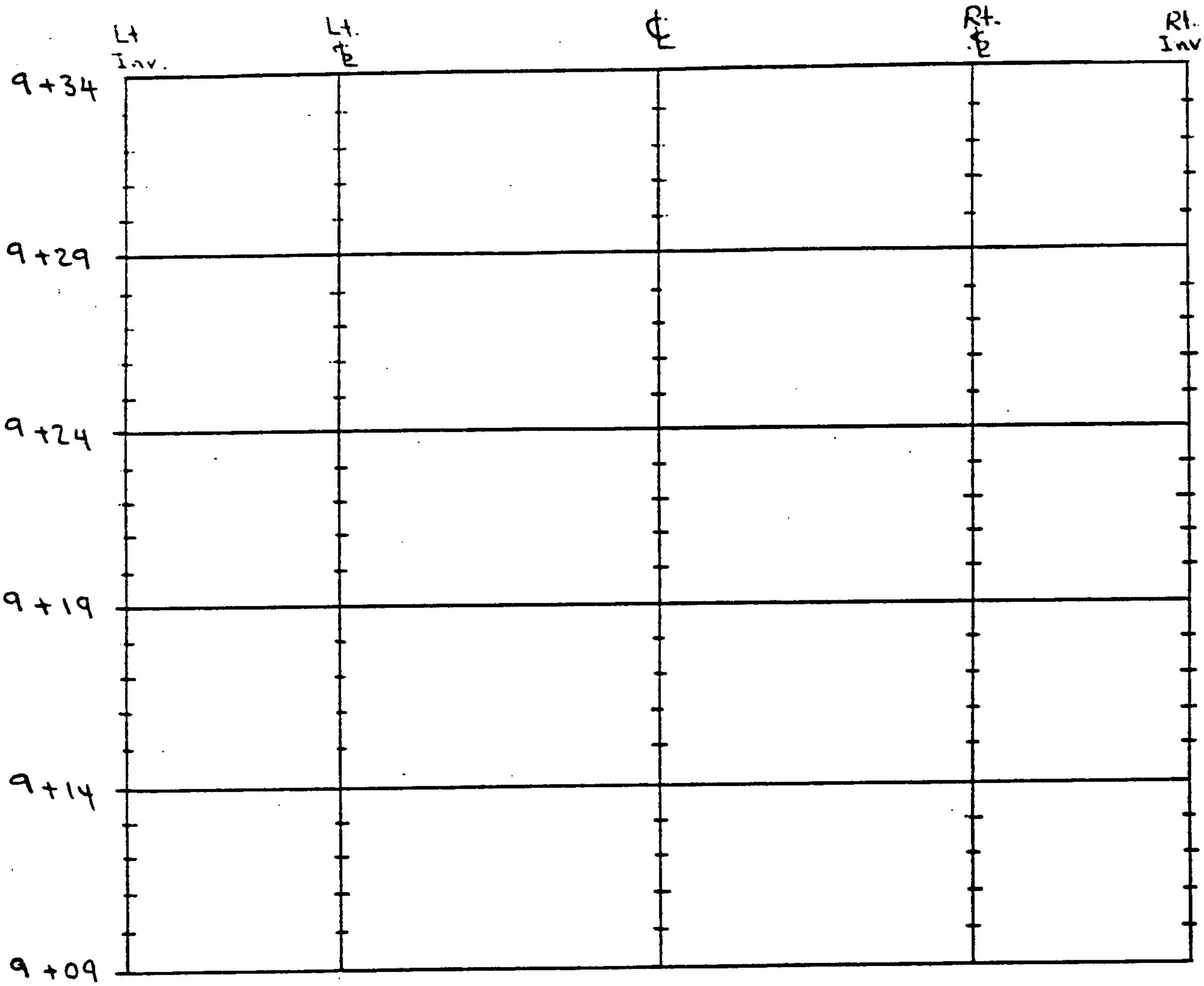
Geologists, Engineers

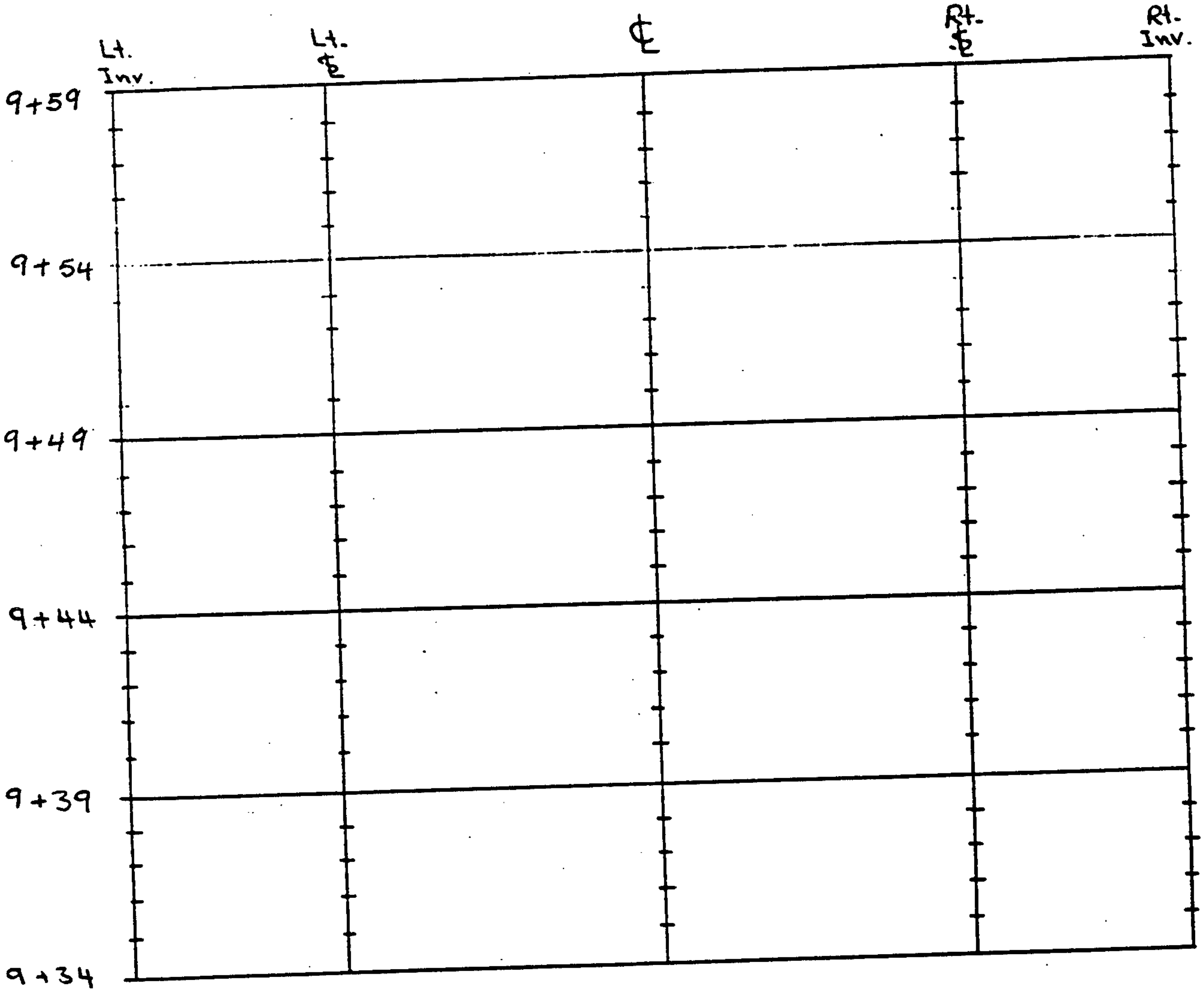
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 34	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

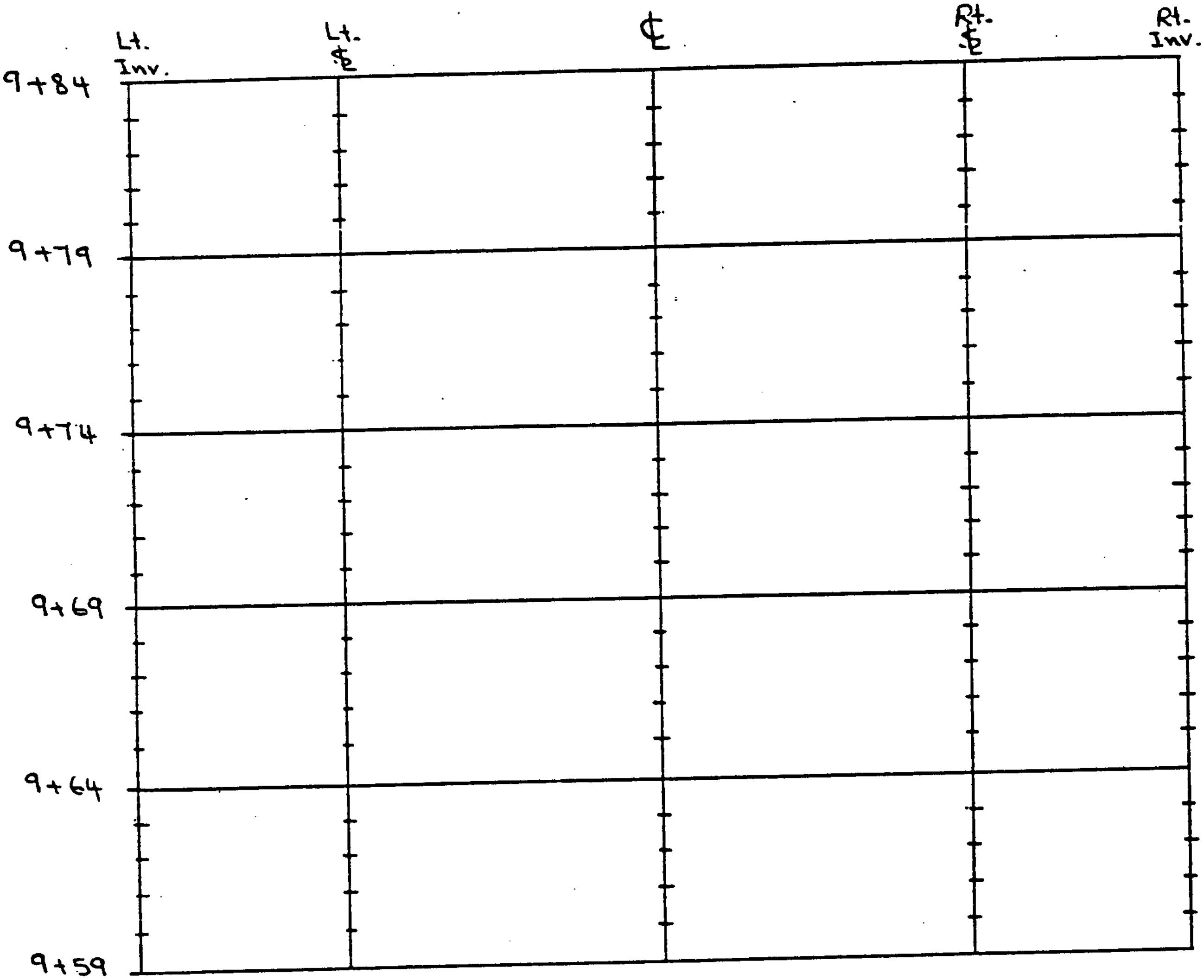
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale	Sheet 35	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

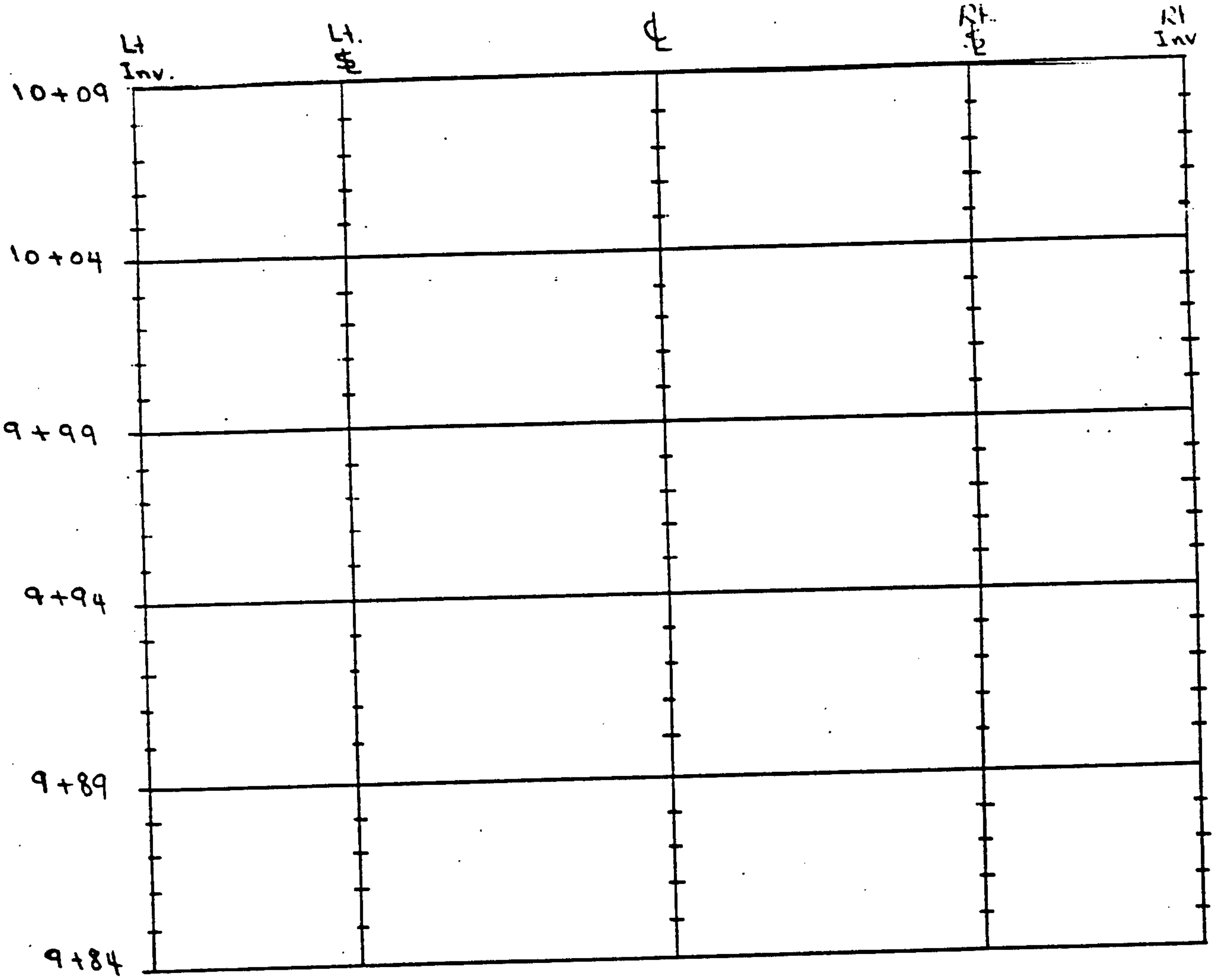
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 36	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

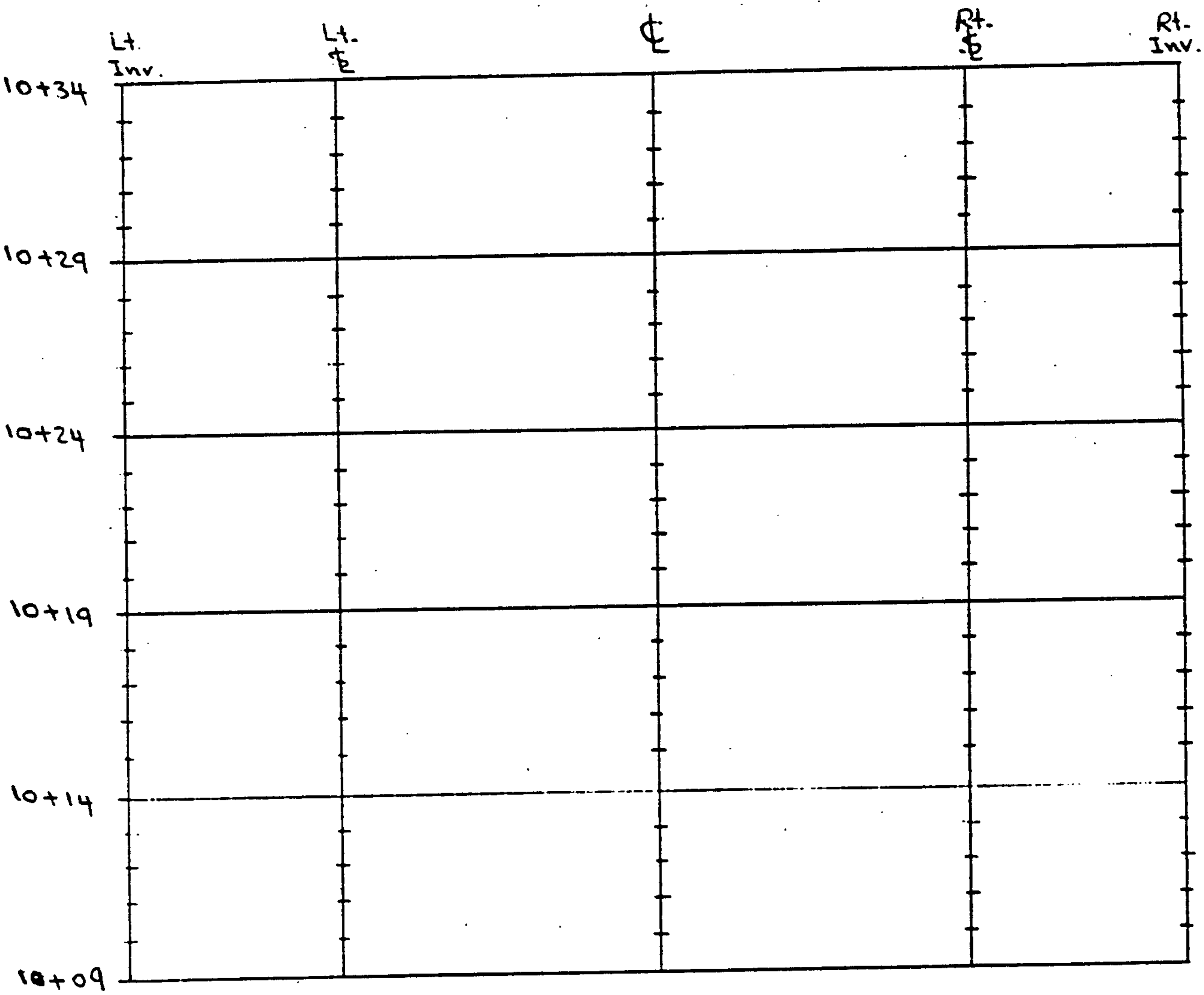
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence Shale	Sheet 37	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 38	Of 72



Massive Rock

LACHEL **& Associates, Inc.**
Geologists, Engineers

Project UTP

Subject

Task Rock : New Providence shale

Computed

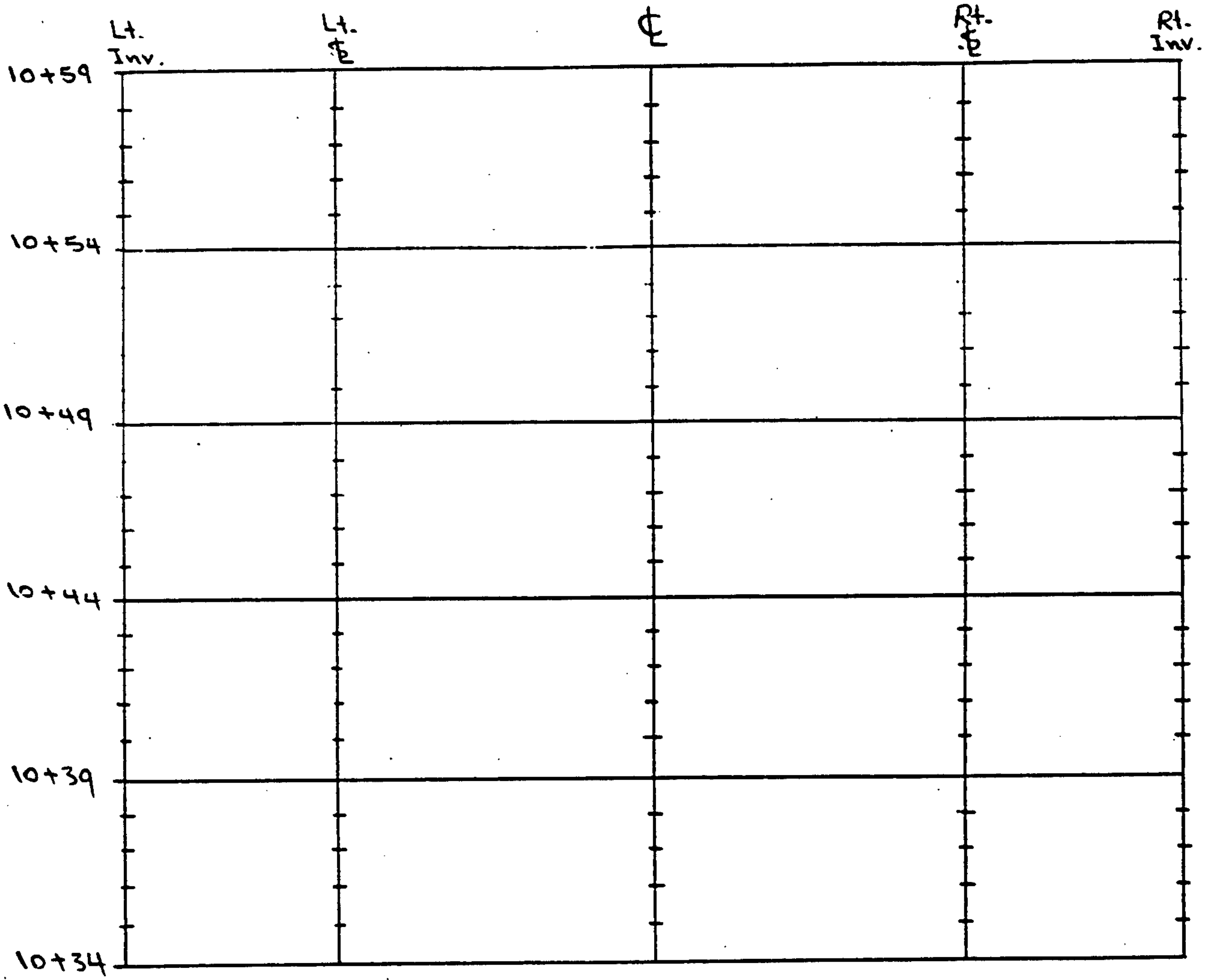
Date

Checked

Date

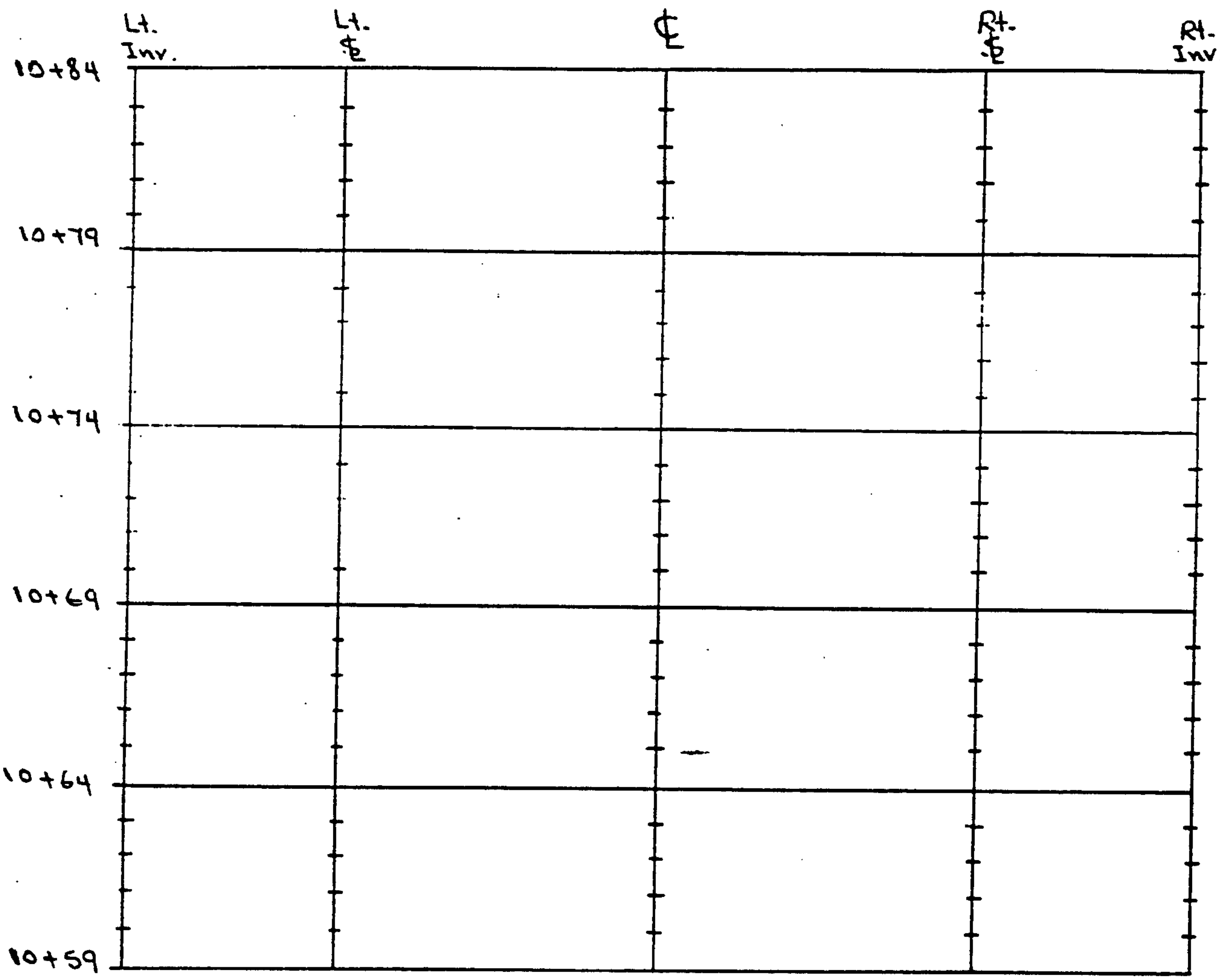
Sheet 39

Of 72



Massive Rock

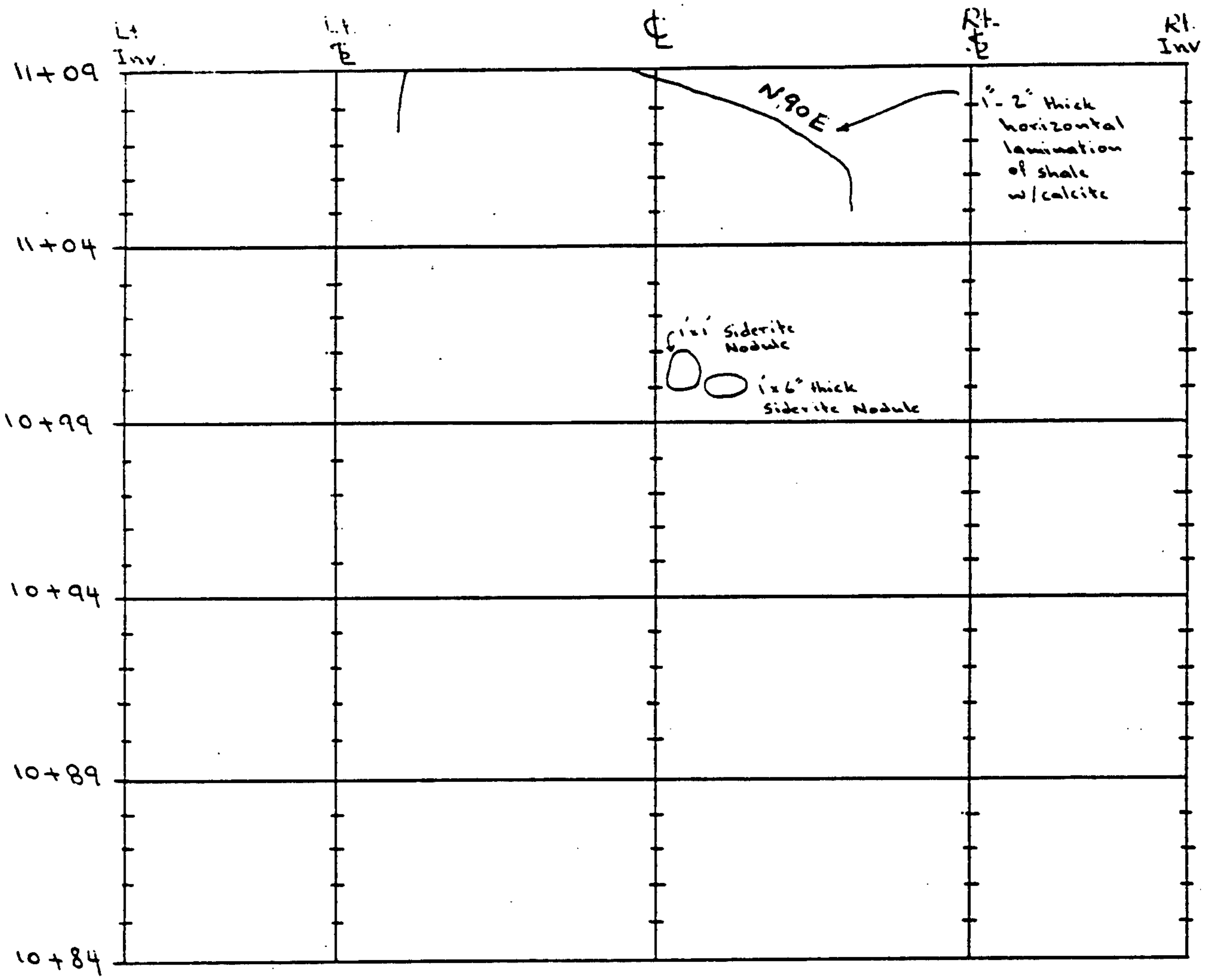
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 40	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

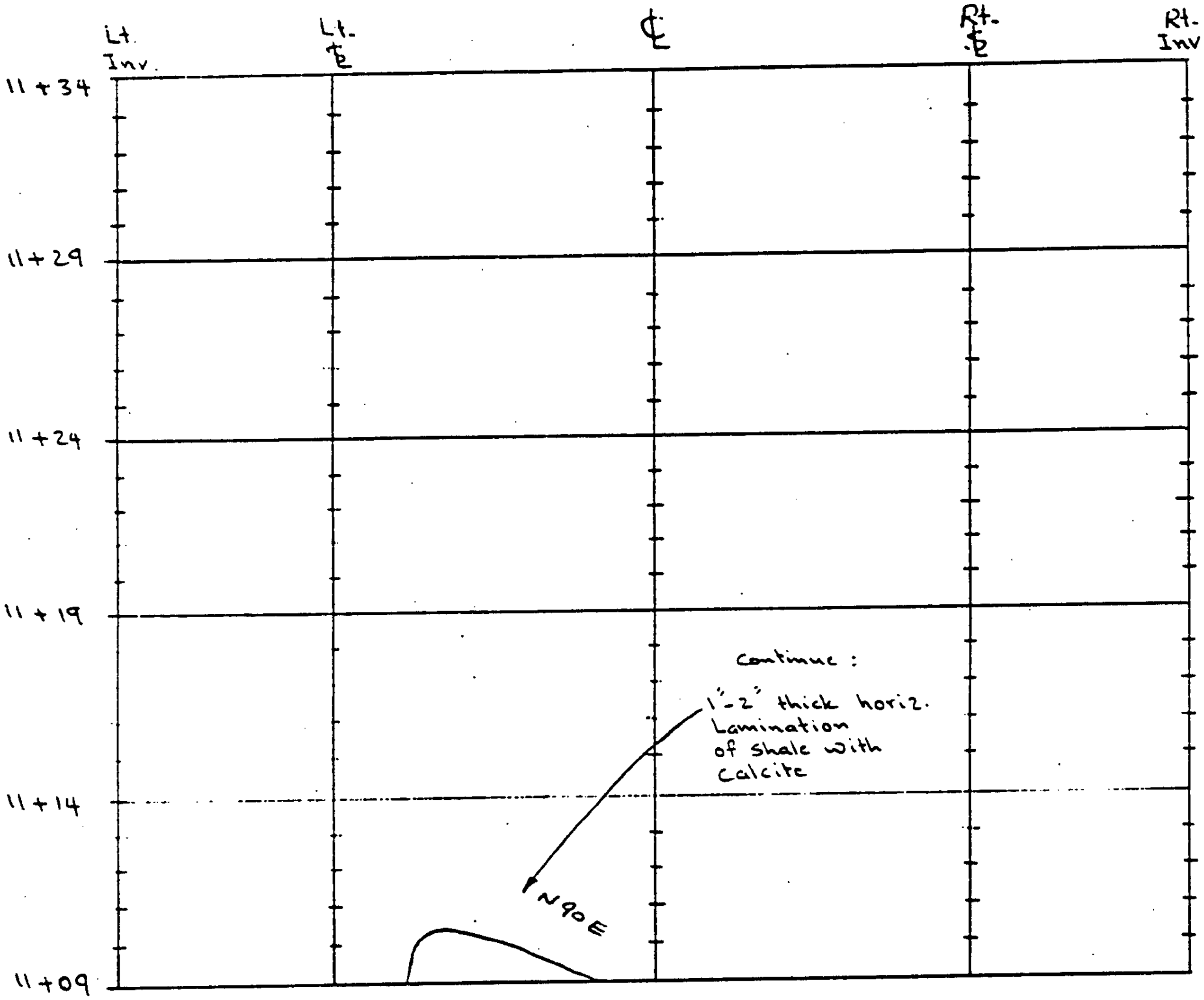
Project UTP | Computed | Date
Subject | Checked | Date
Task Rock New Providence Shale | Sheet 41 | Of 72



Massive Rock

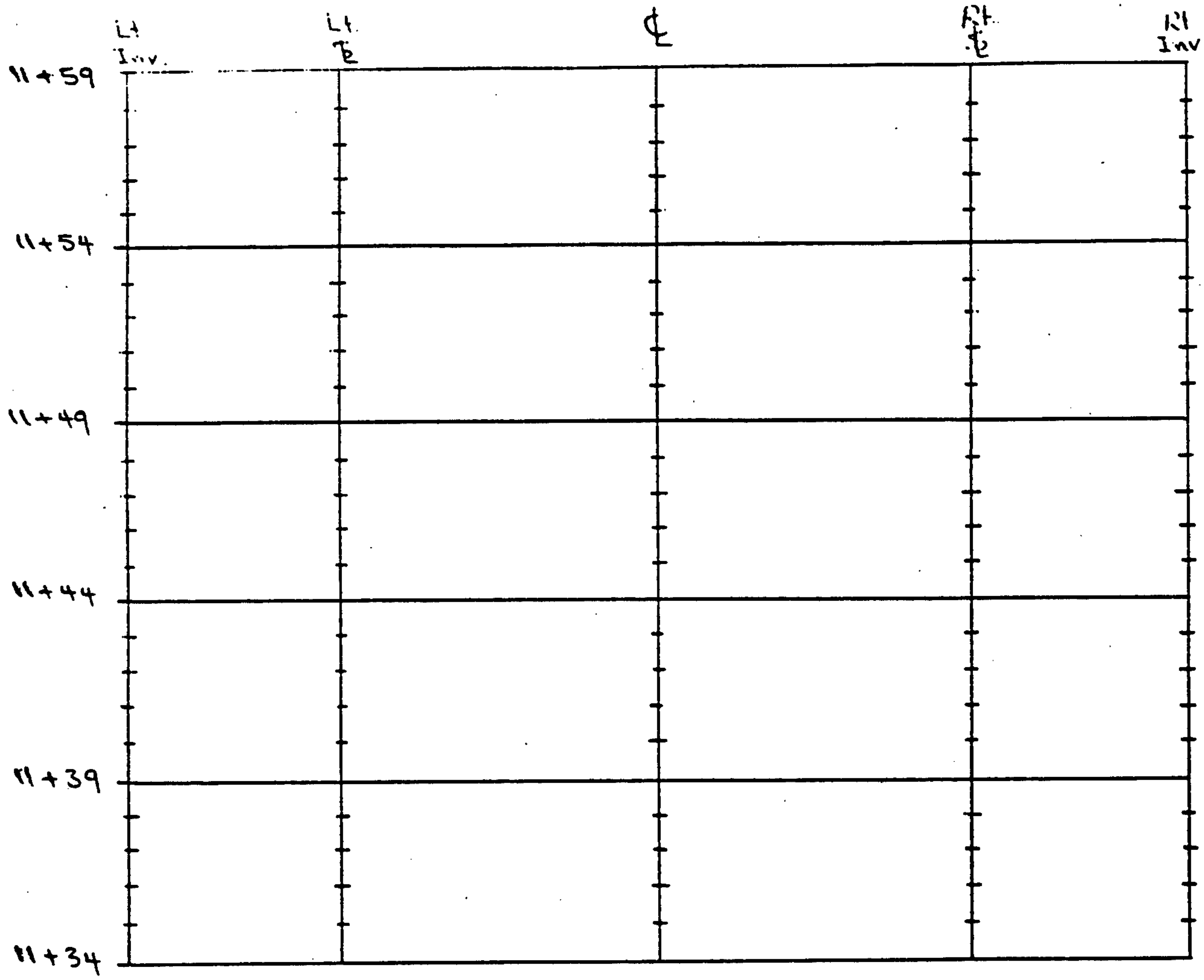
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : N. P. shale	Sheet 42	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

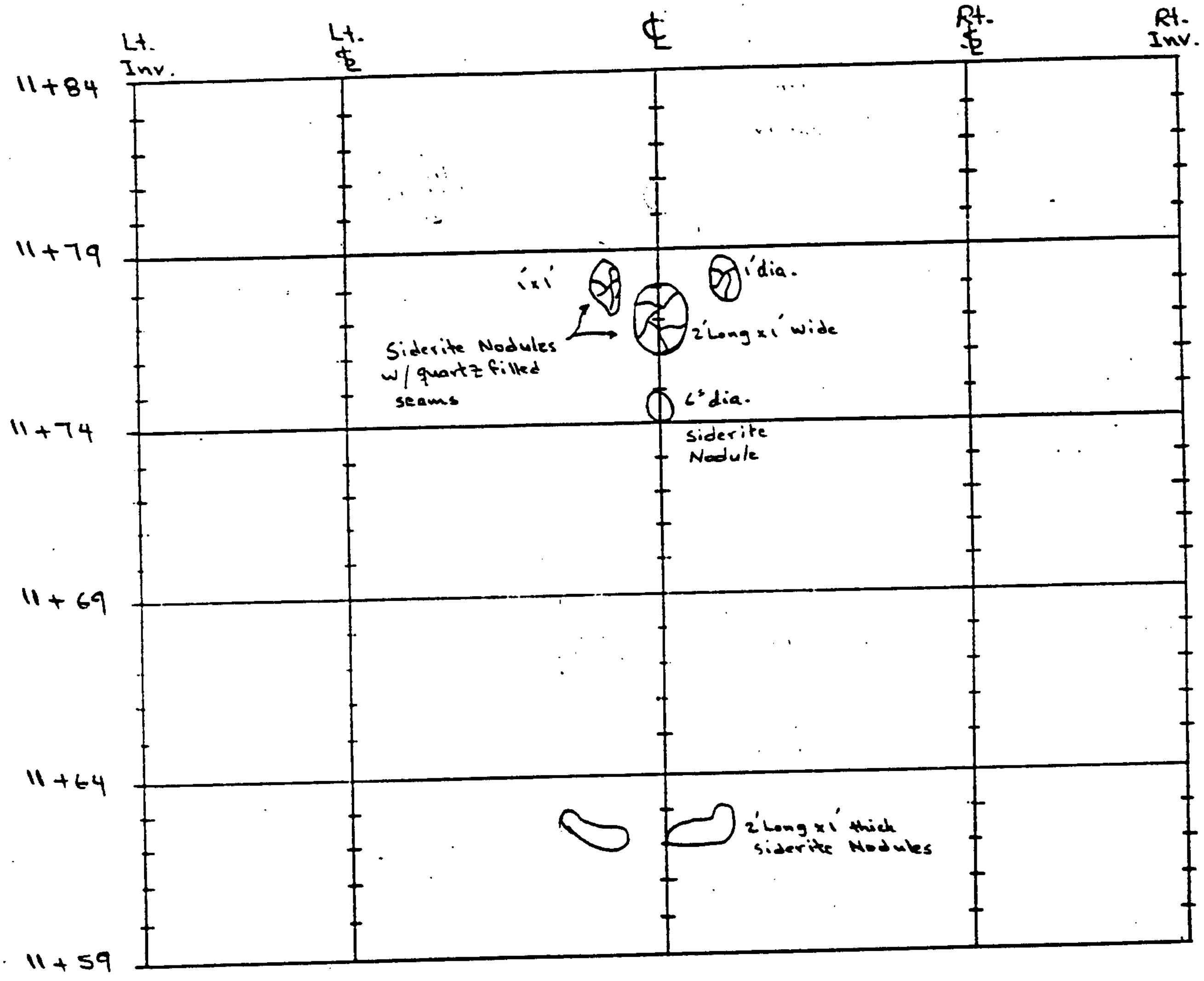
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: N.P. shale	Sheet 43	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

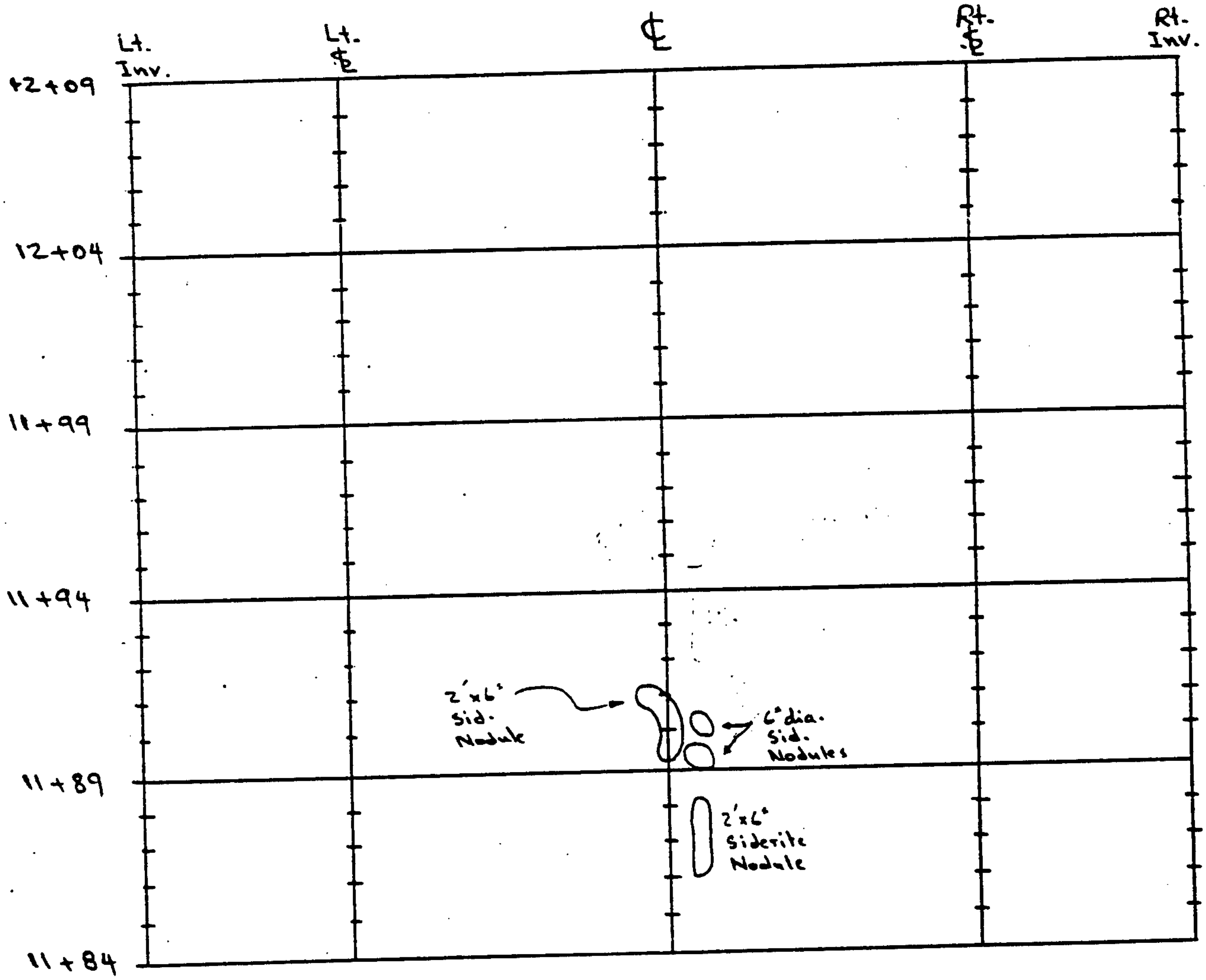
Project UTP	Computed	Date
Subject	Checked	Date
Task N. P. shale	Sheet 44	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

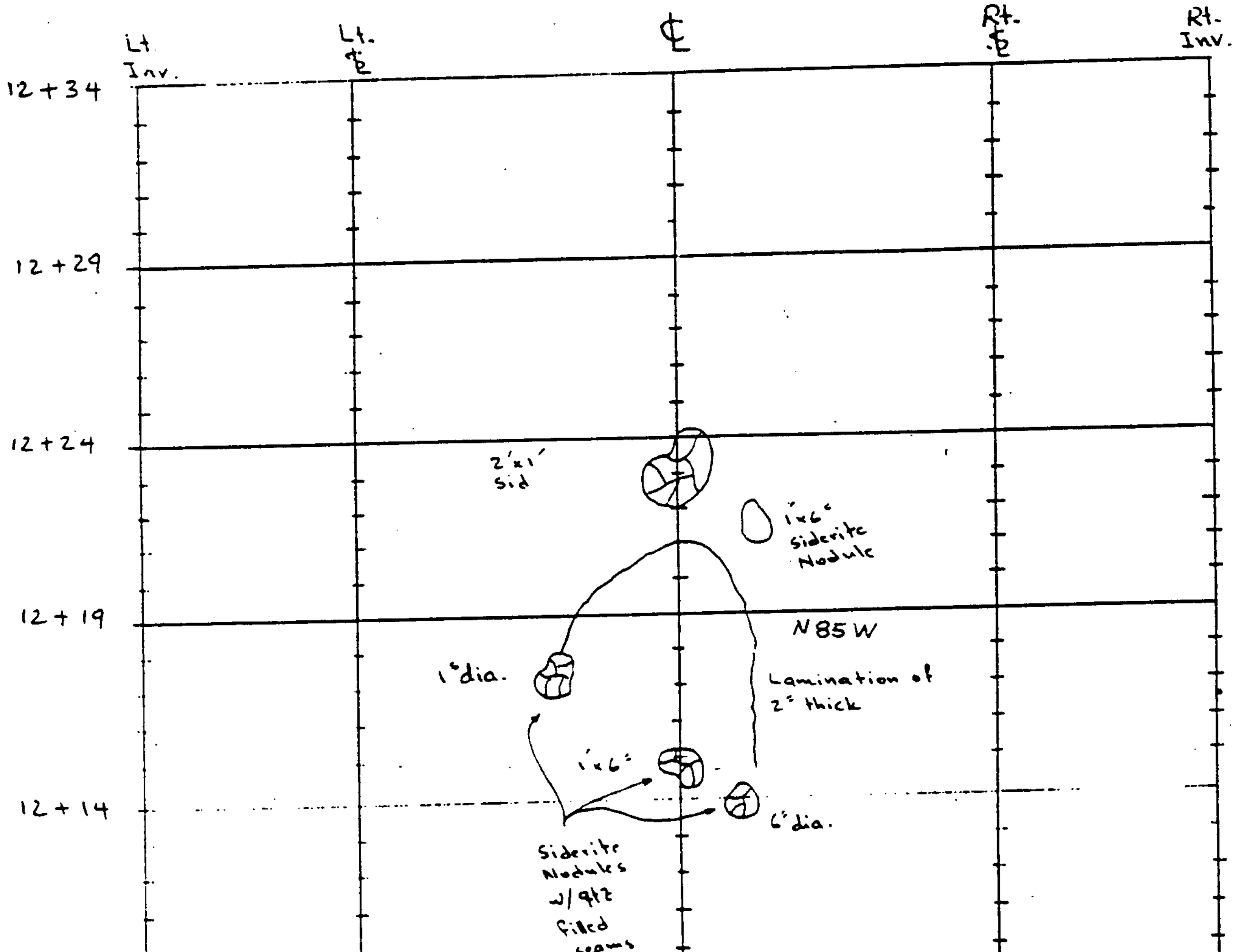
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : N. P. shale	Sheet 45	Of 72



Massive Rock

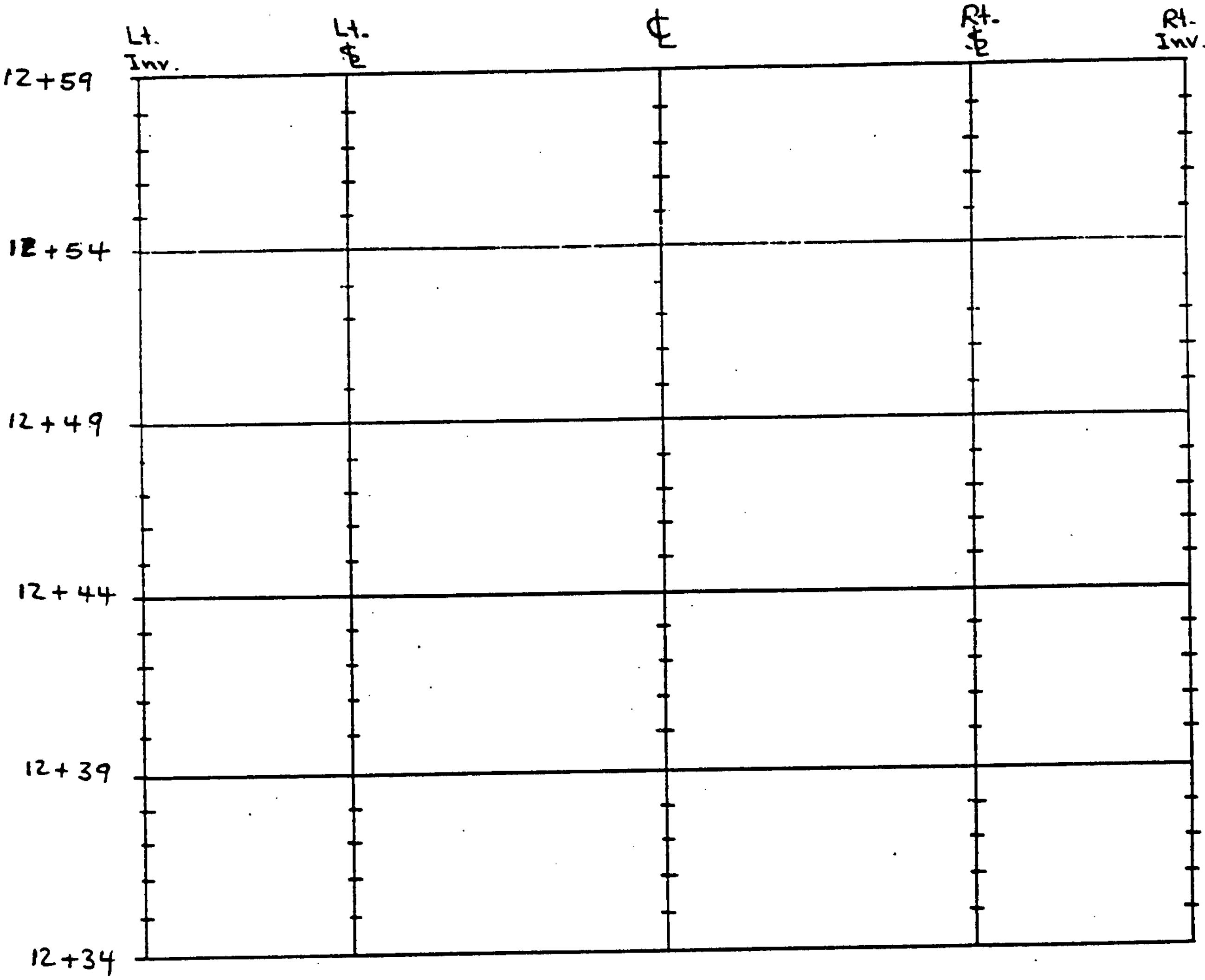
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : N.P. Shale	Sheet 46	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

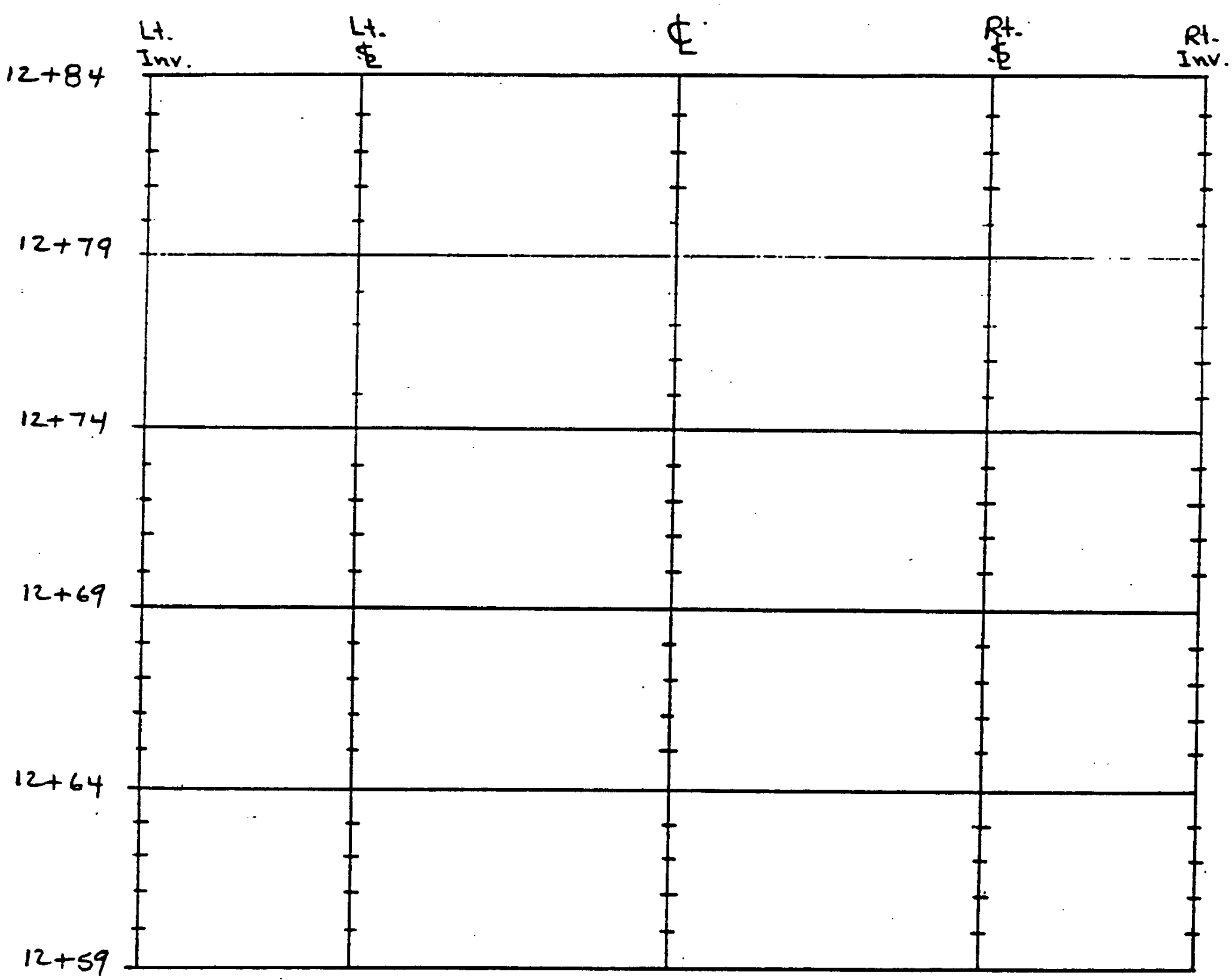
Project UTP		Computed	Date
Subject		Checked	Date
Task Rock: New Providence Shale		Sheet 47	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

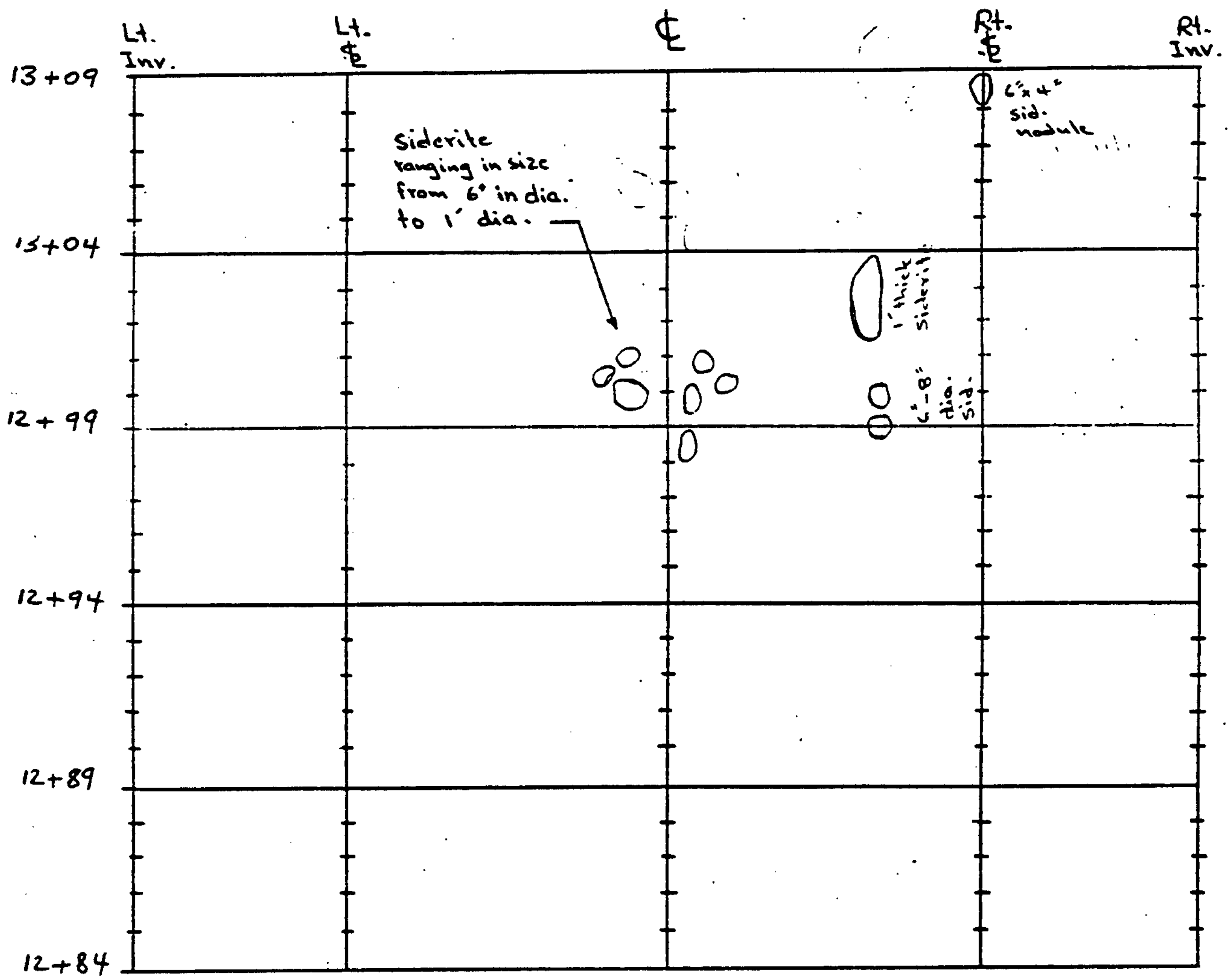
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Prov. Shale	Sheet 48	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

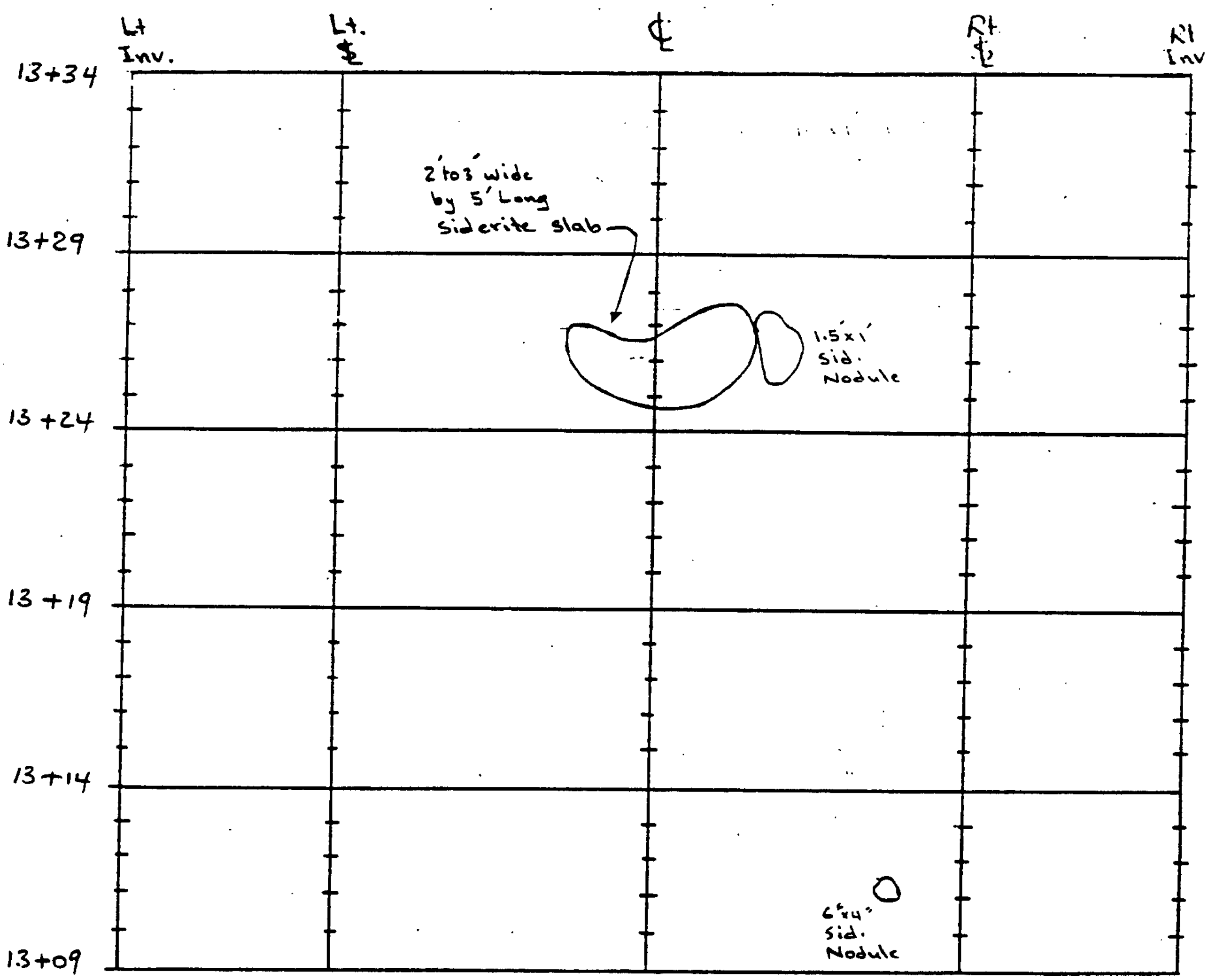
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Provid. shale	Sheet 49	Of 72



Massive Rock

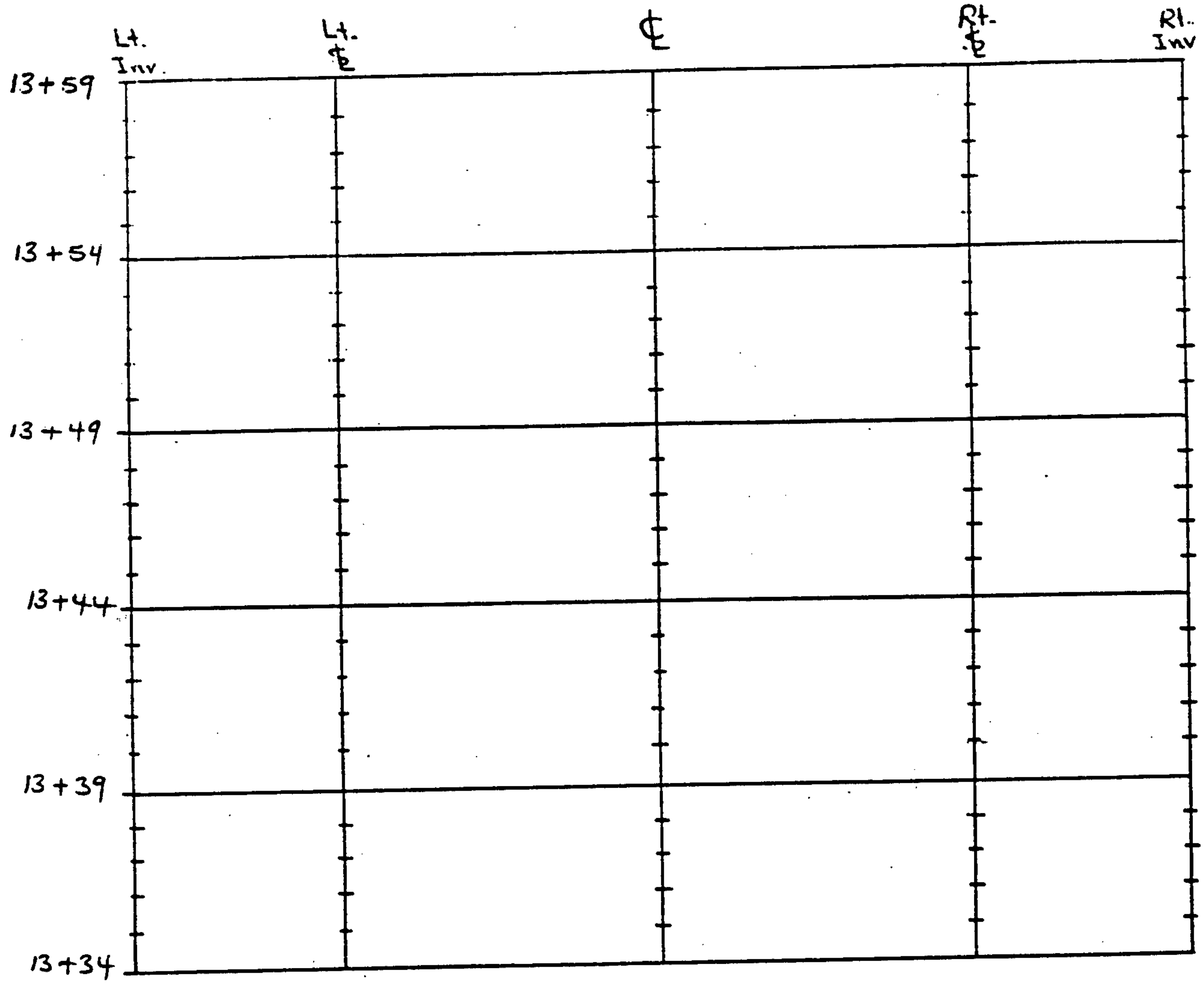
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence shale	Sheet 50	Of 72



Massive Rock

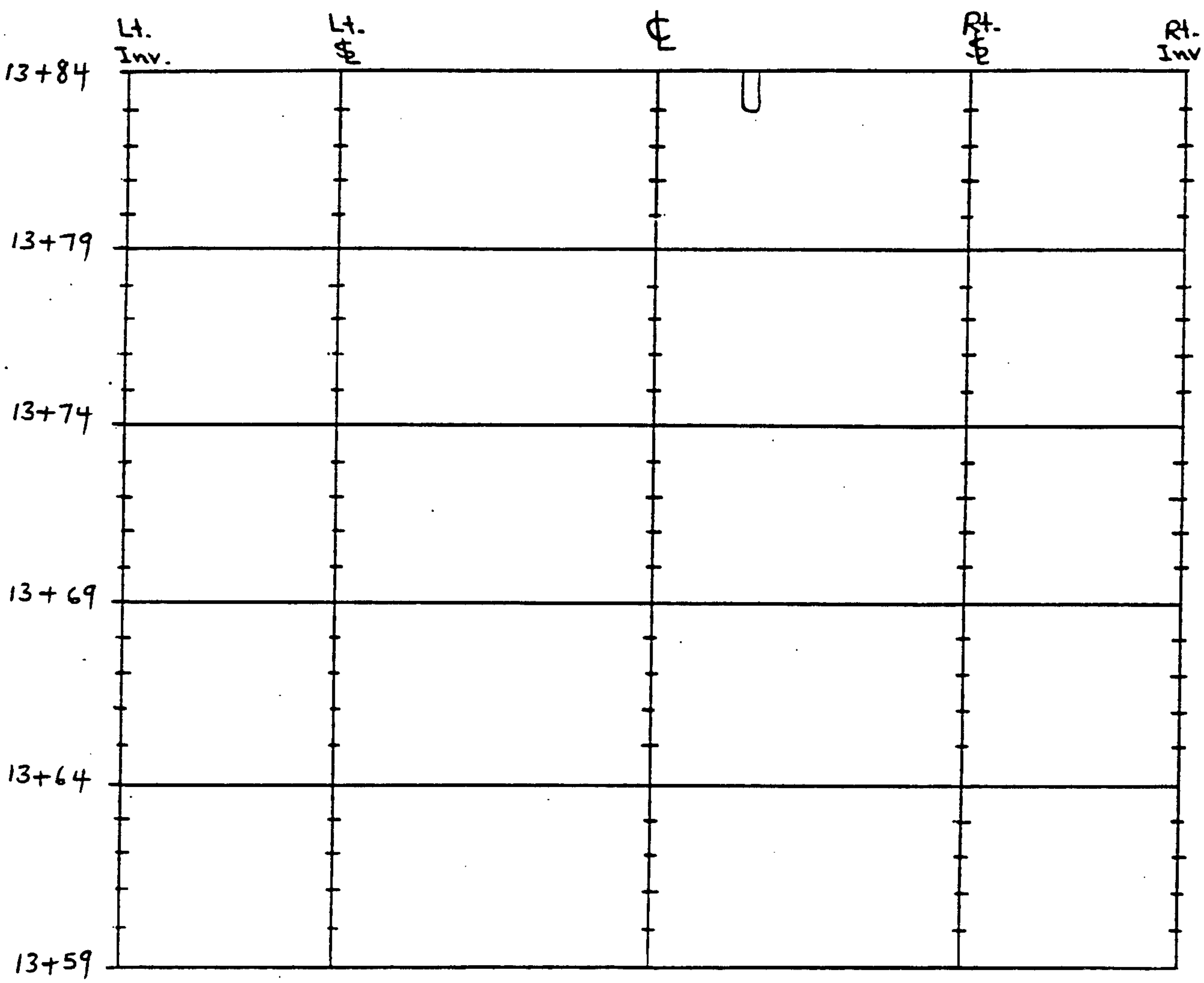
Project UTP		Computed	Date
Subject		Checked	Date
Task Rock : New Prov. shale		Sheet 51	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

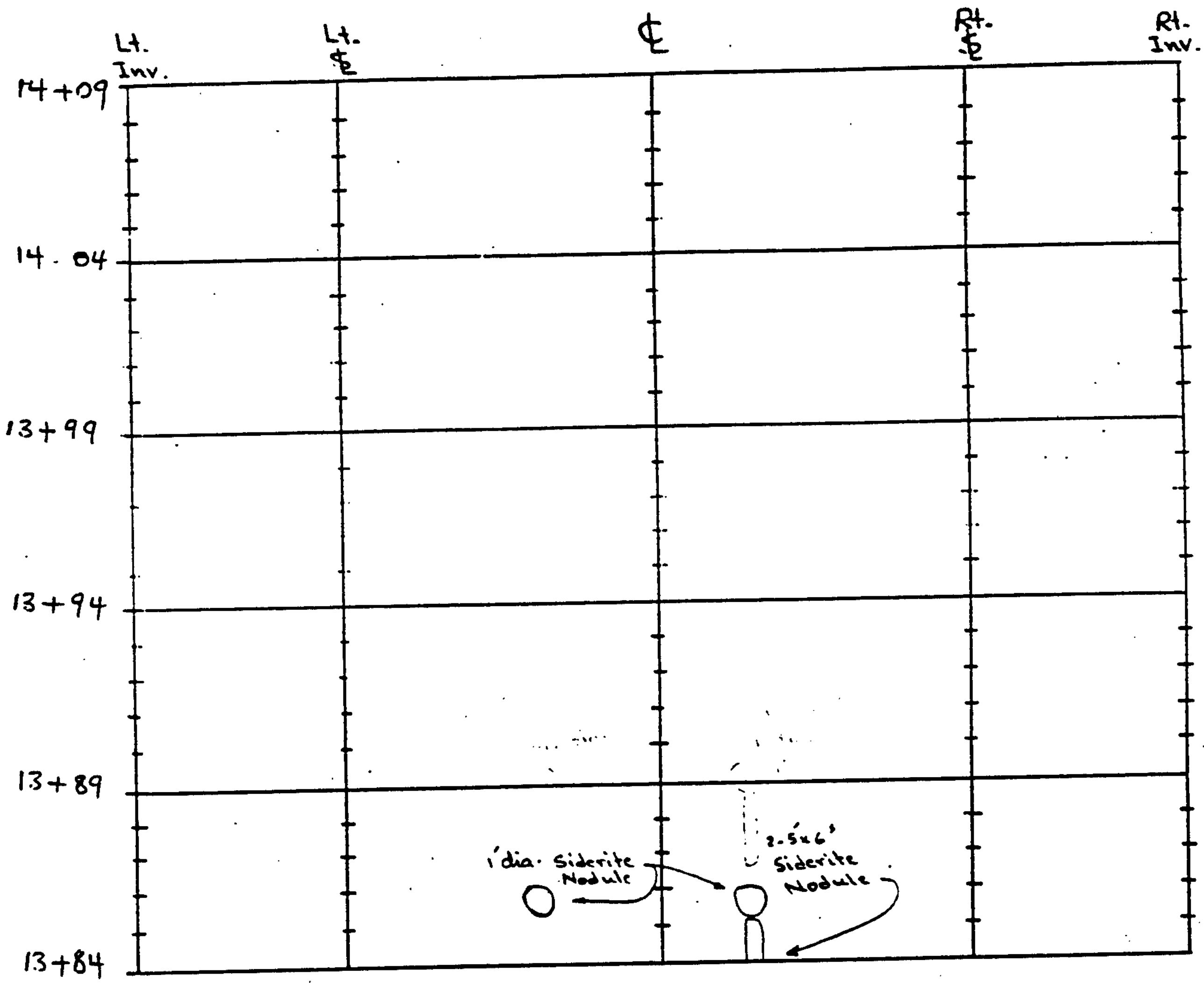
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock: New Prov. shale	Sheet 52	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

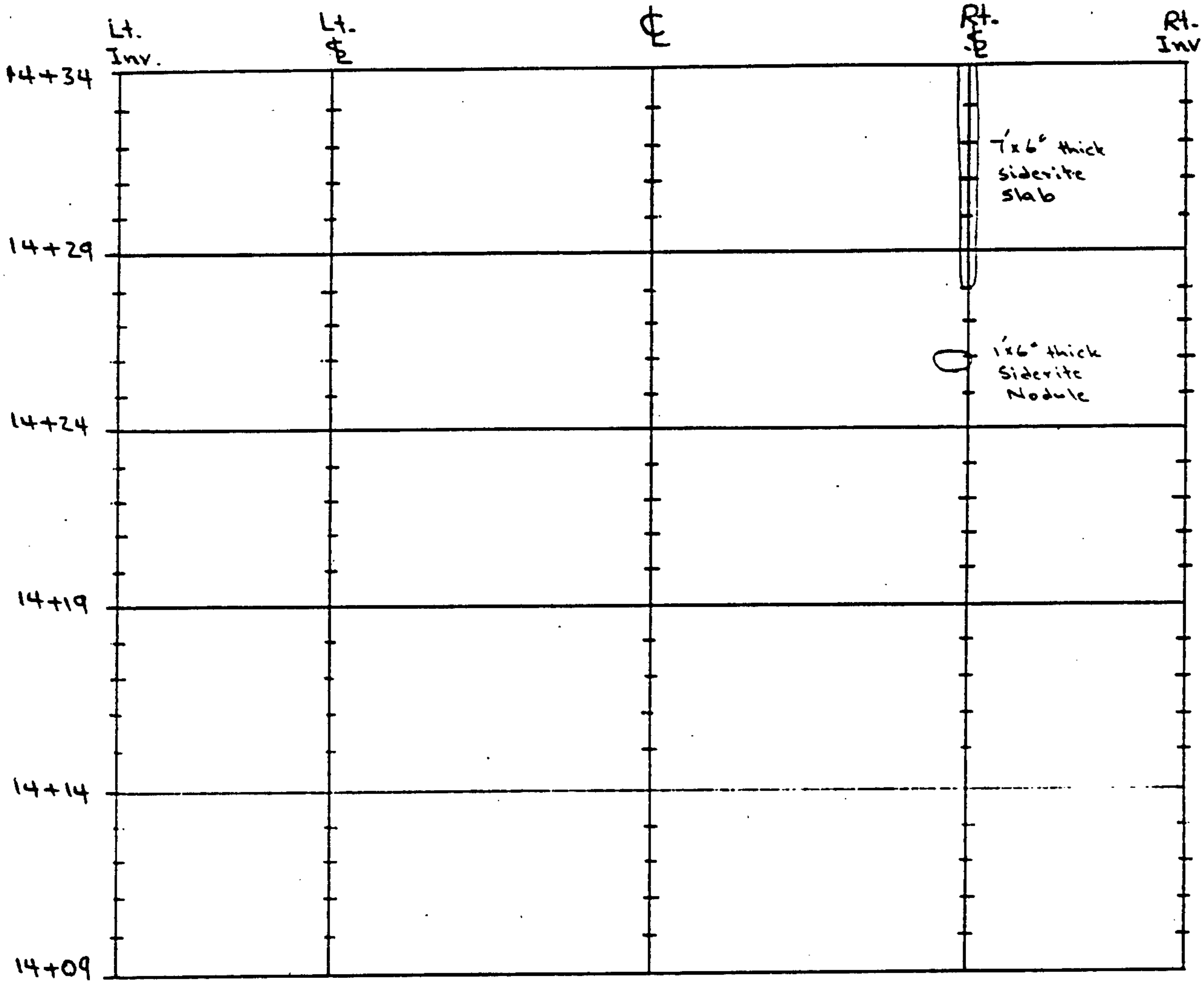
Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence shale	Sheet 53	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task Rock : New Providence shale	Sheet 54	Of 72

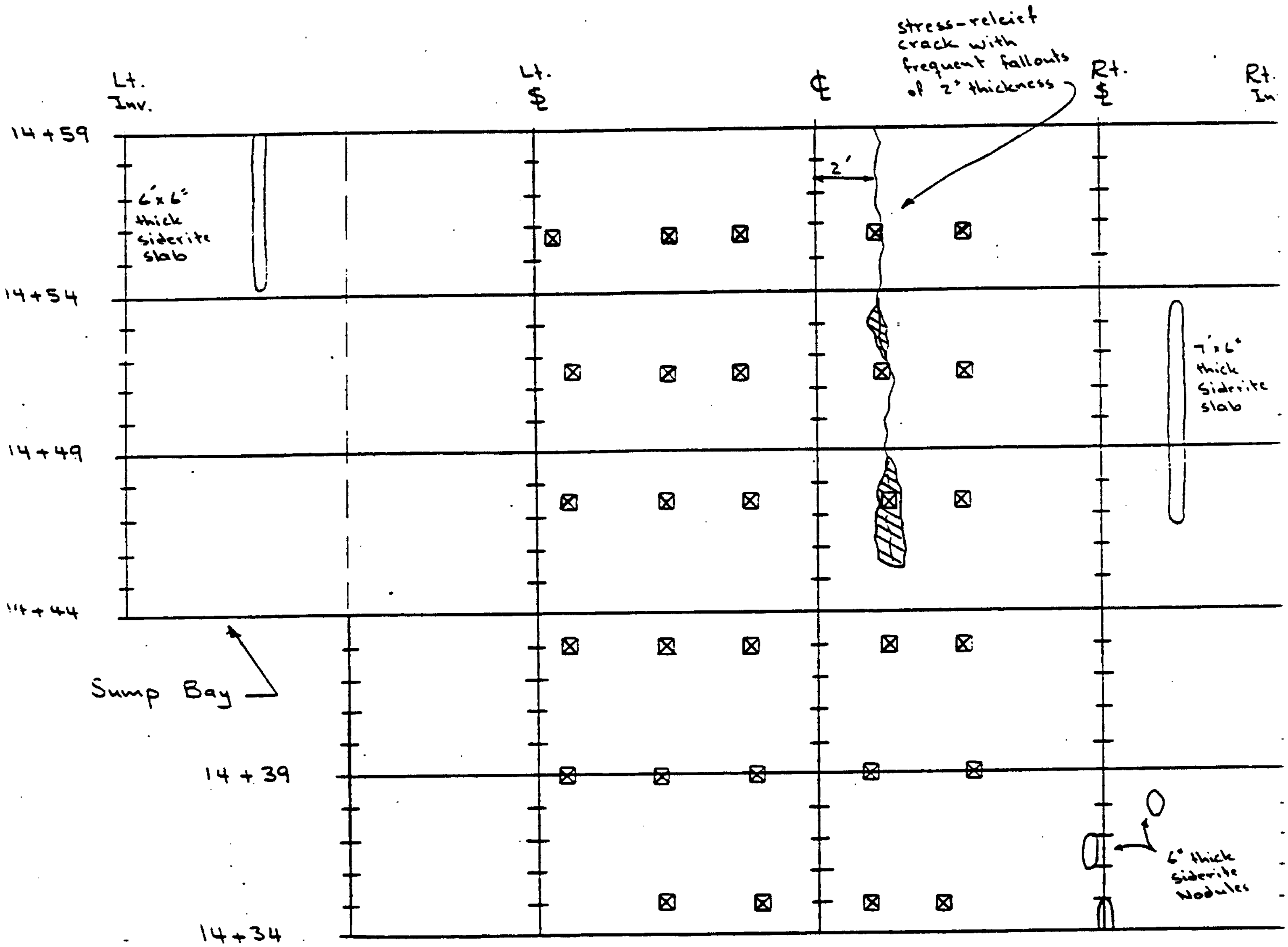


Massive Rock

Job No. | No

LACHEL & Associates, Inc.
Geologists, Engineers

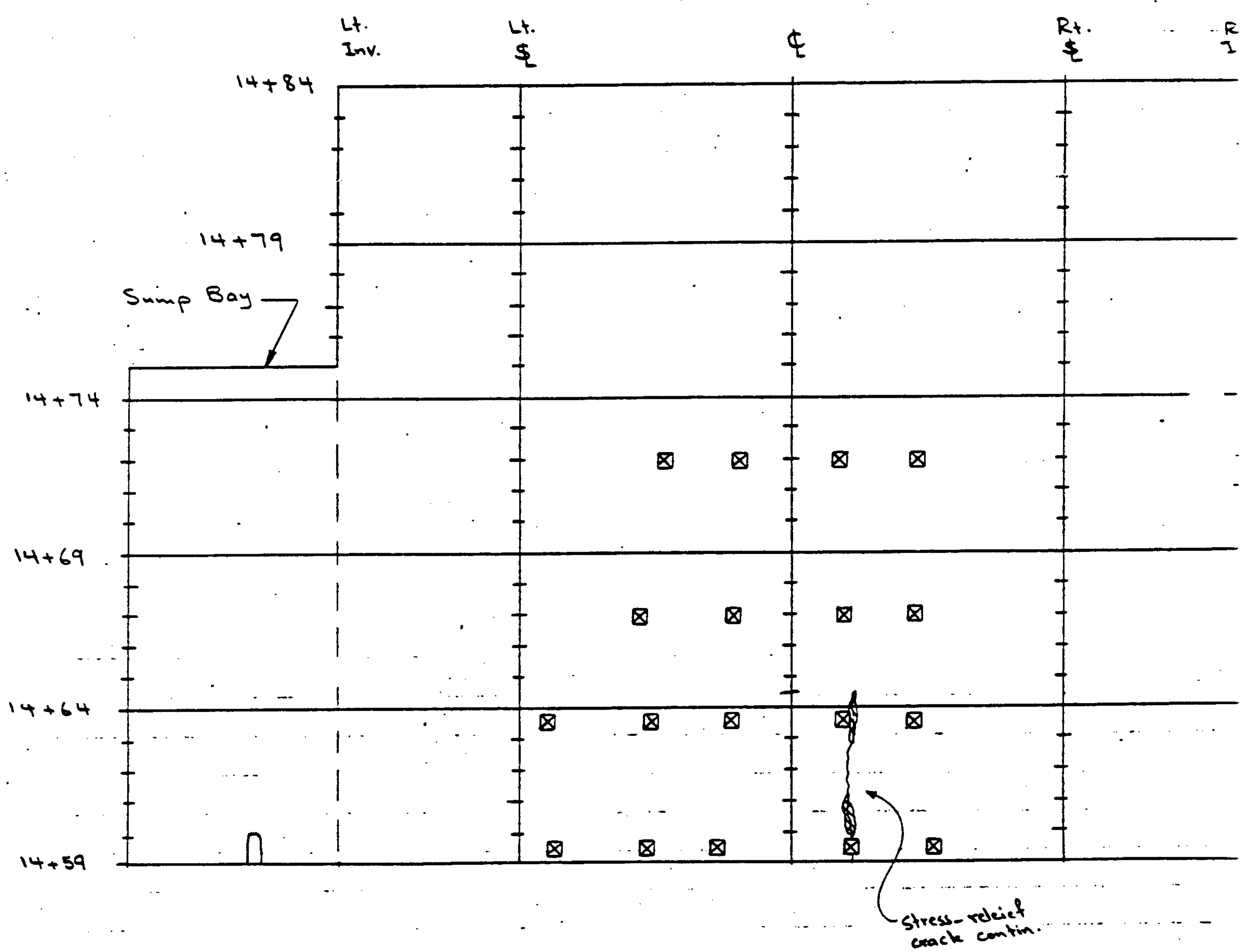
Project UTP		Computed	Date
Subject Sump Bay - Geologic Mapping		Checked	Date
Task Rock: New Providence Shale		Sheet 55	Of 72



Massive Rock

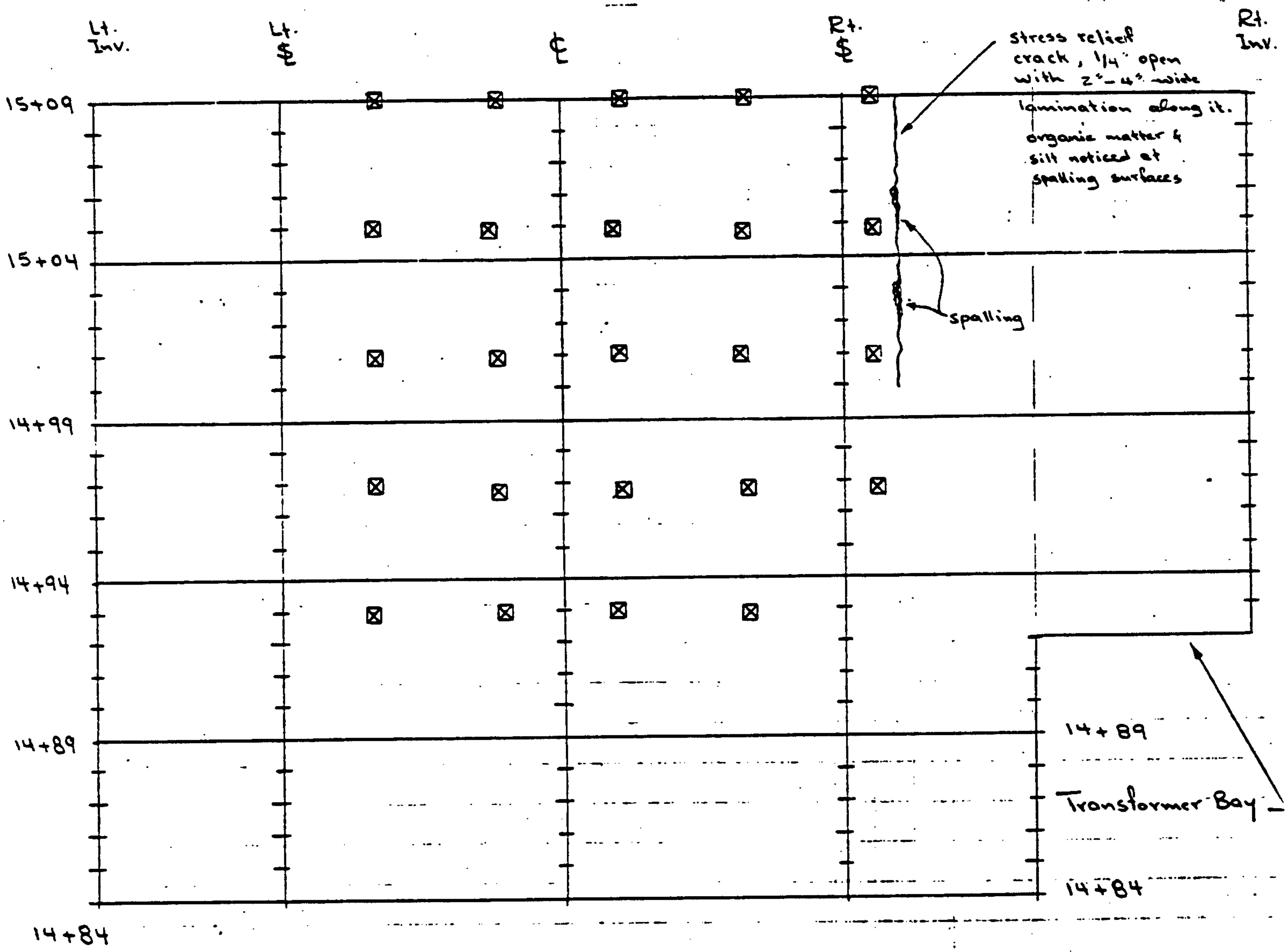
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 56	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

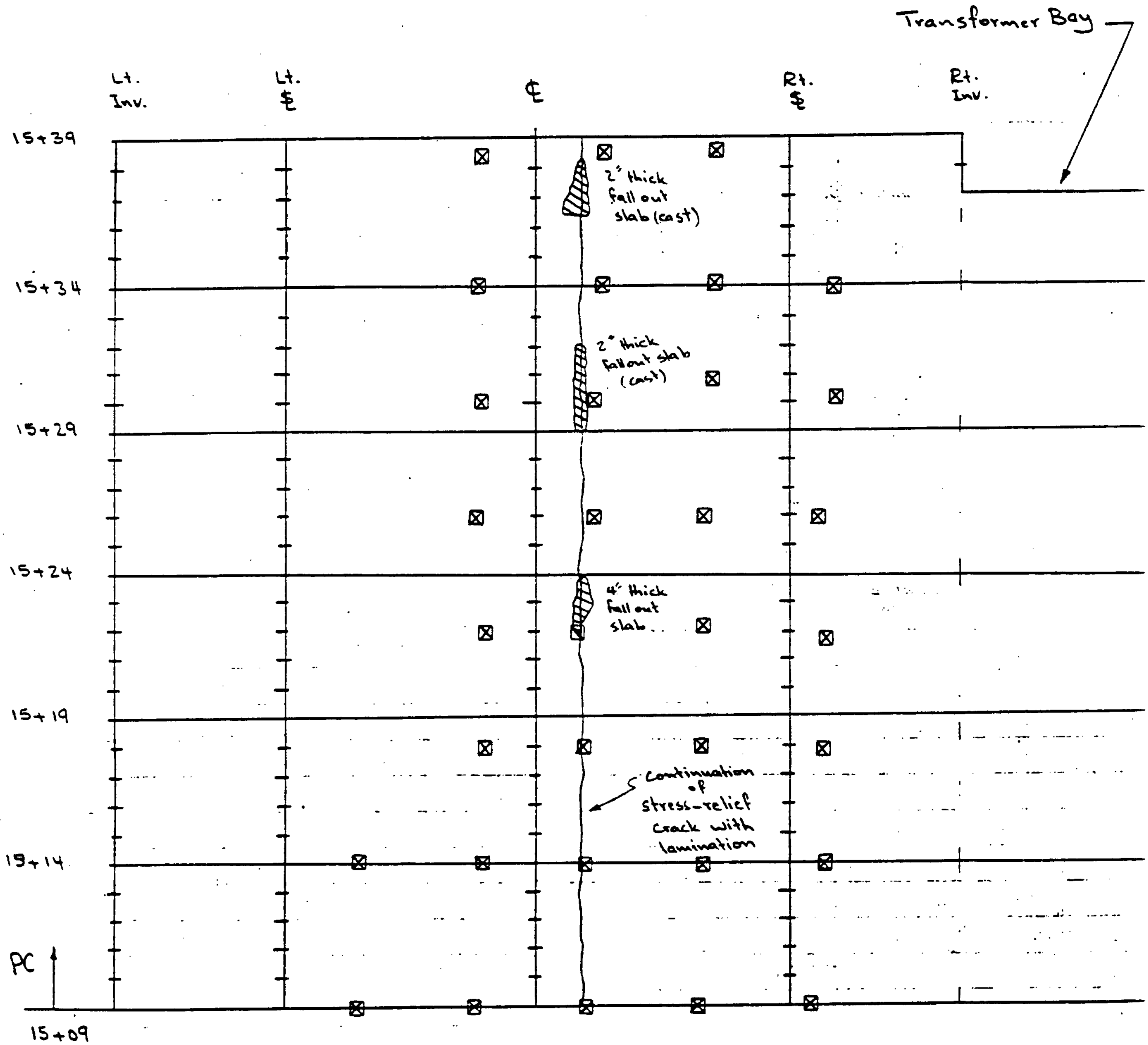
Project UTP		Computed	Date
Subject Transformer Bay - Geologic Mapping		Checked	Date
Task Rock: New Providence Shale		Sheet 57	of 72



Job No.

LACHEL & Associates, Inc.
Geologists, Engineers

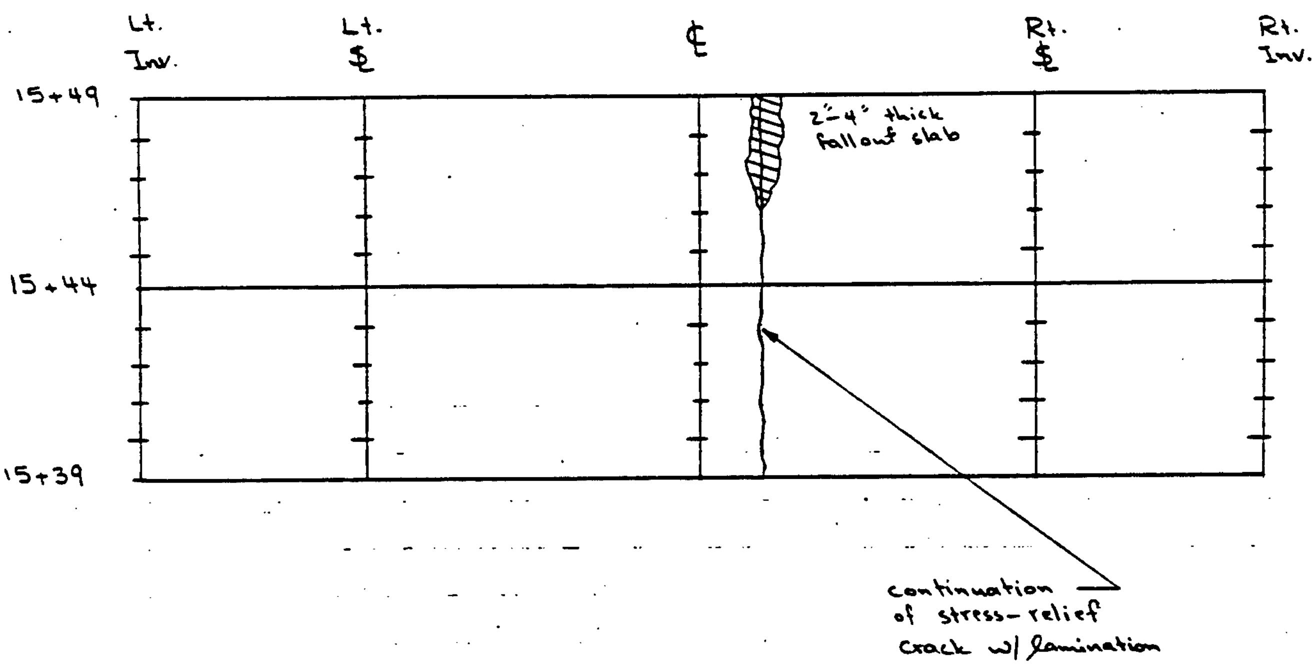
Project UTP		Computed	Date
Subject		Checked	Date
Task		Sheet 58	Of 72



* Tunnel starts to curve to the left @ Sta. 15+09 (PC) but curve is not shown here for ease.

LACHEL & Associates, Inc.
Geologists, Engineers

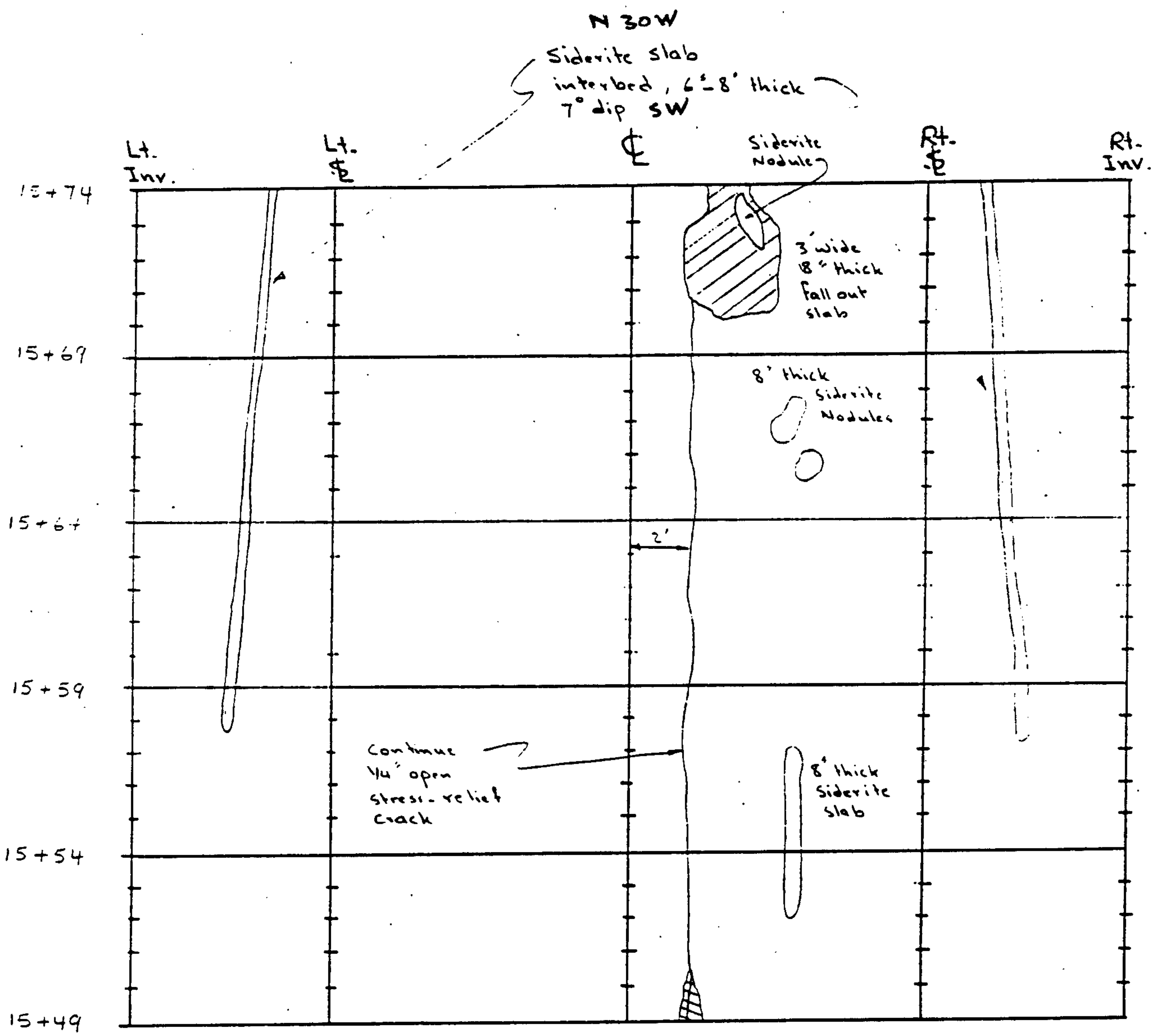
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 59	Of 72



Job No. | No.

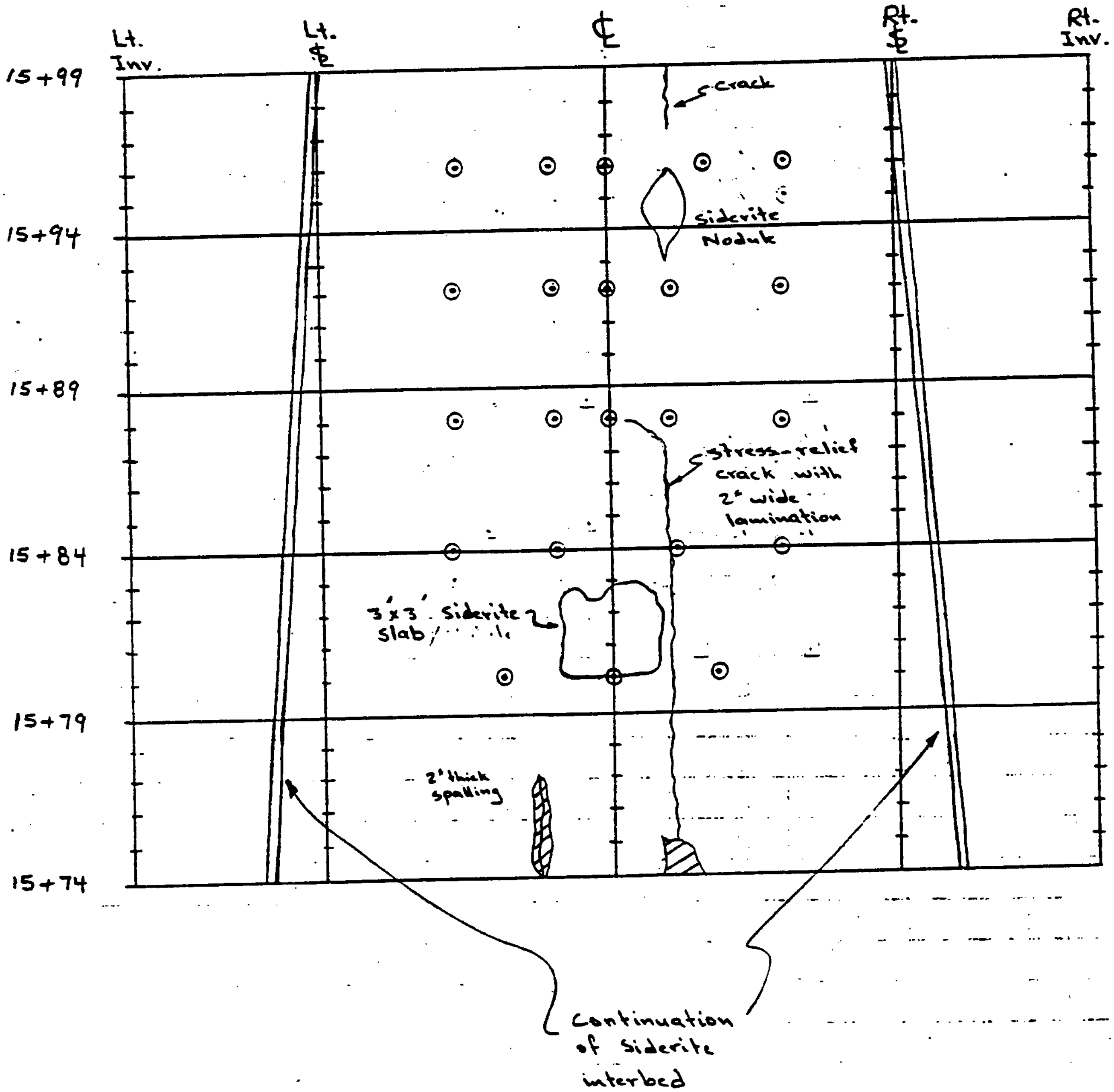
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 60	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

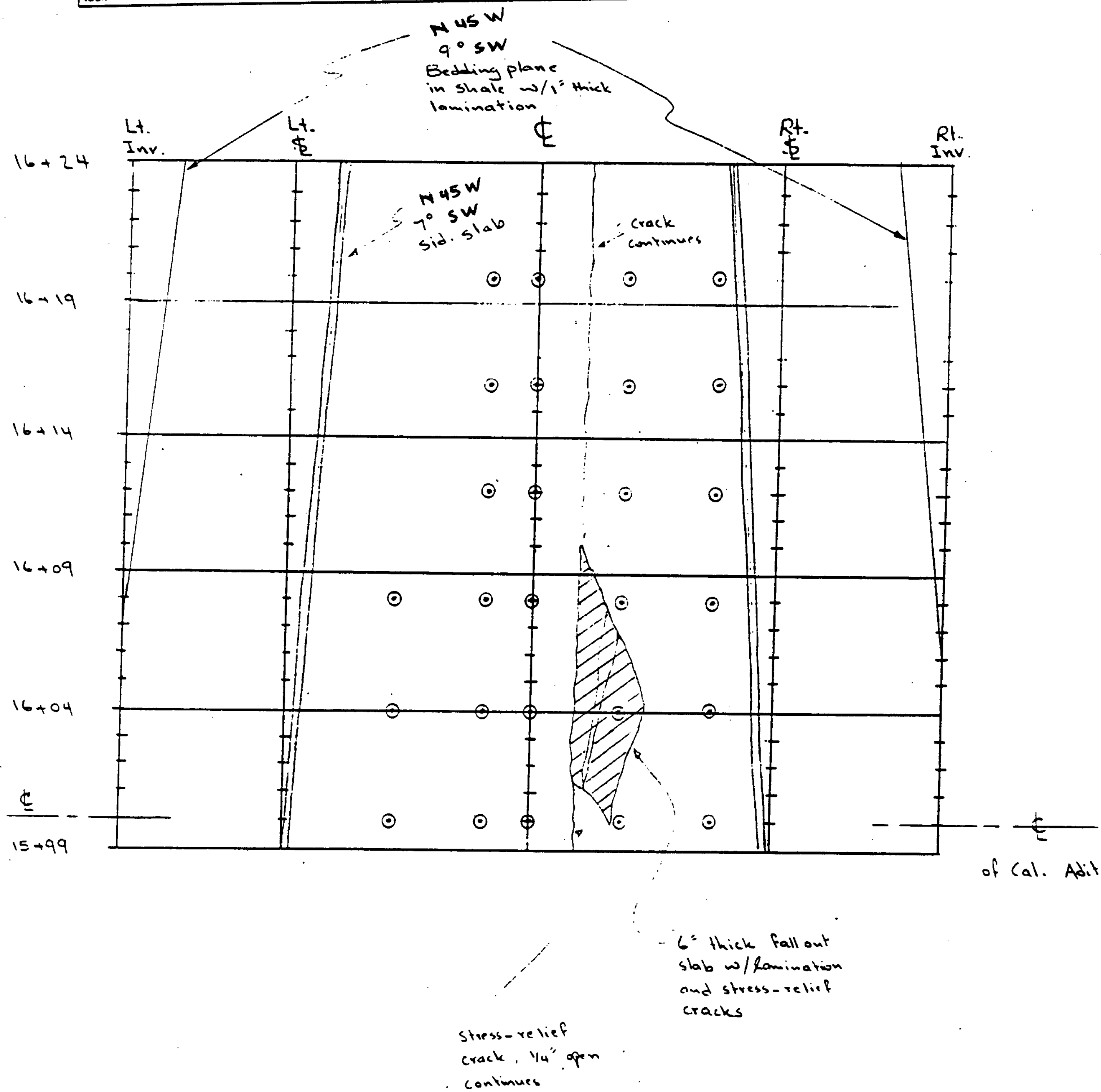
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 61	Of 72



Job No. | No.

LACHEL & Associates, Inc.
Geologists, Engineers

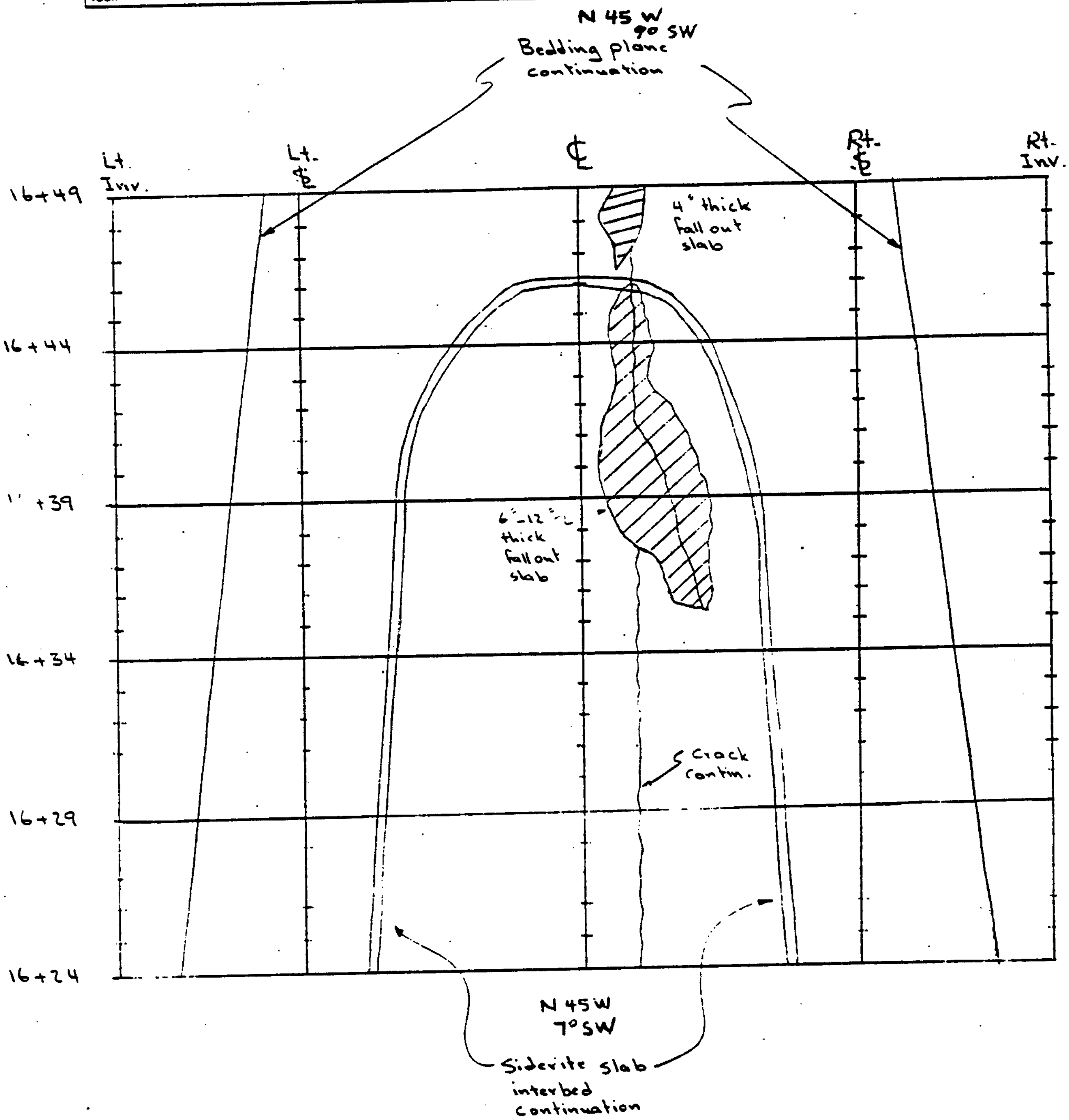
Project UTP		Computed	Date
Subject		Checked	Date
Task		Sheet 62	Of 72



Job No. No.

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 63	of 72

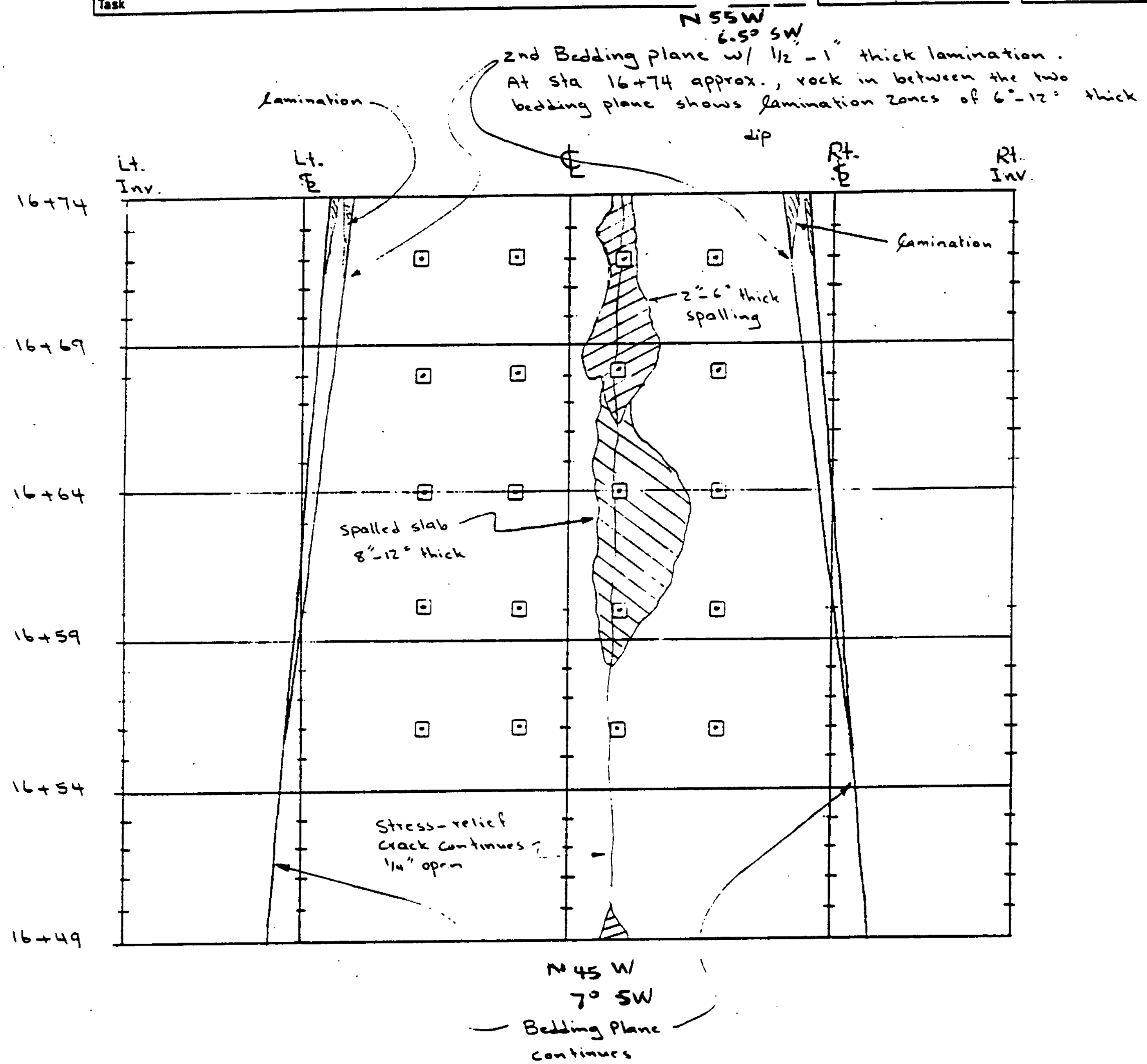


Notice: stress relief crack starts developing at 15 - 20 ft from heading as excavation progresses. Most falling rock start coming down in big chunks at about 20 ft from heading & only after 12 to 18 hours of exposure of newly excavated shale.

Job No. | No.

LACHEL & Associates, Inc.
Geologists, Engineers

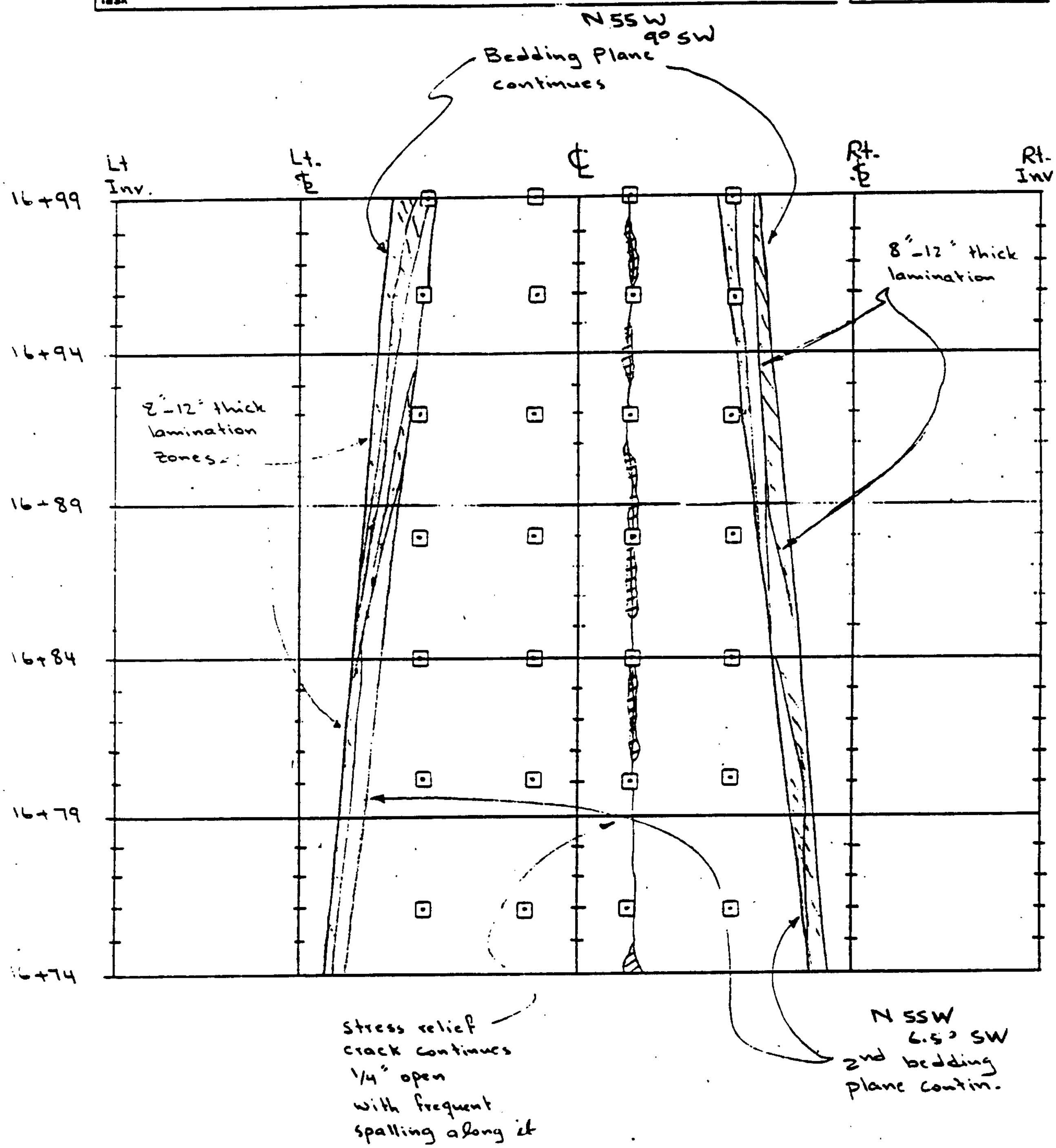
Project UTP | Computed | Date
Subject | Checked | Date
Task | Sheet 64 | Of 72



Job No.	No.

LACHEL & Associates, Inc.
Geologists, Engineers

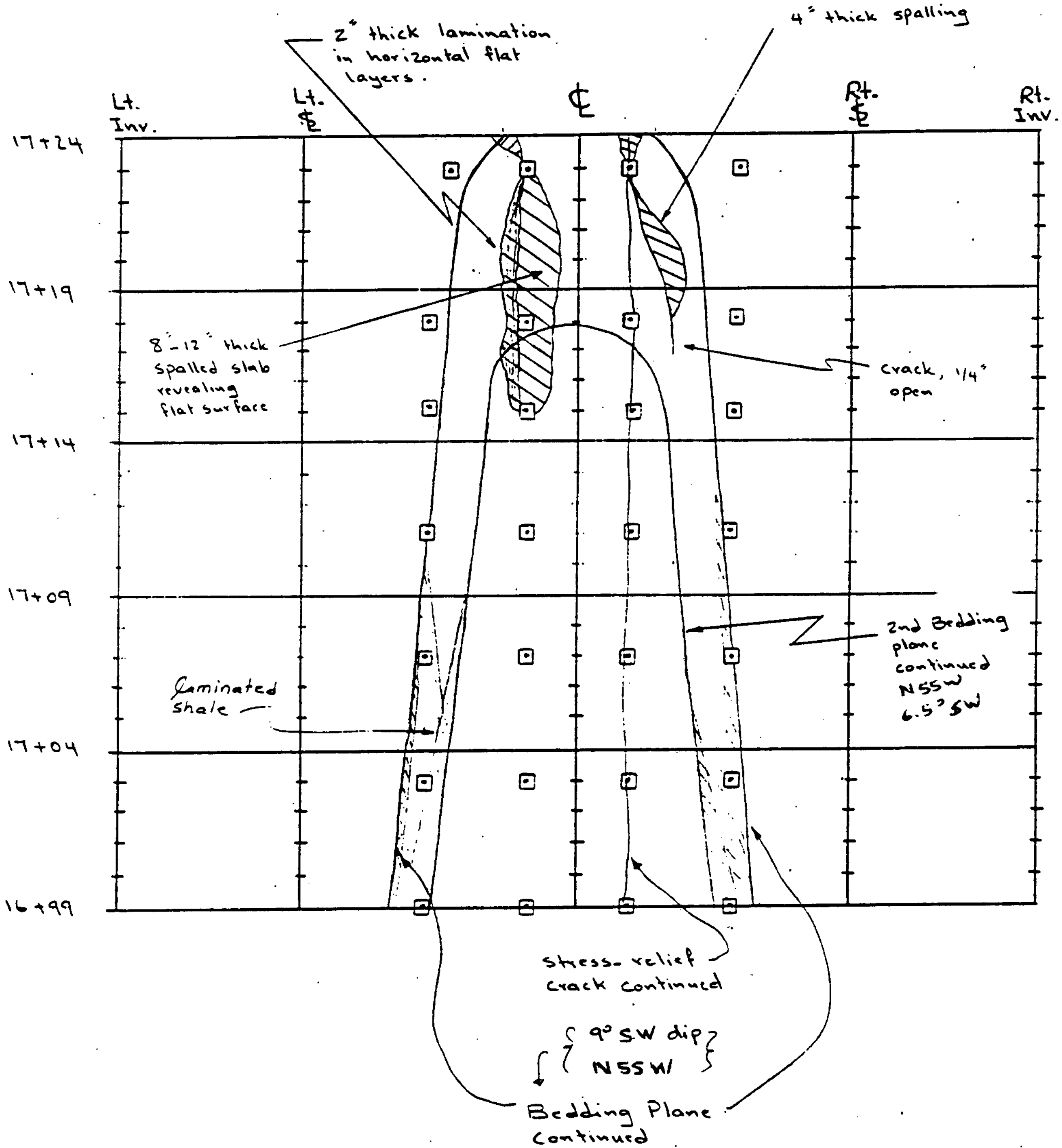
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 65	Of 72



Job No. | No.

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP | Computed | Date
Subject | Checked | Date
Task | Sheet 66 | Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP

Subject

Task

Computed | Date

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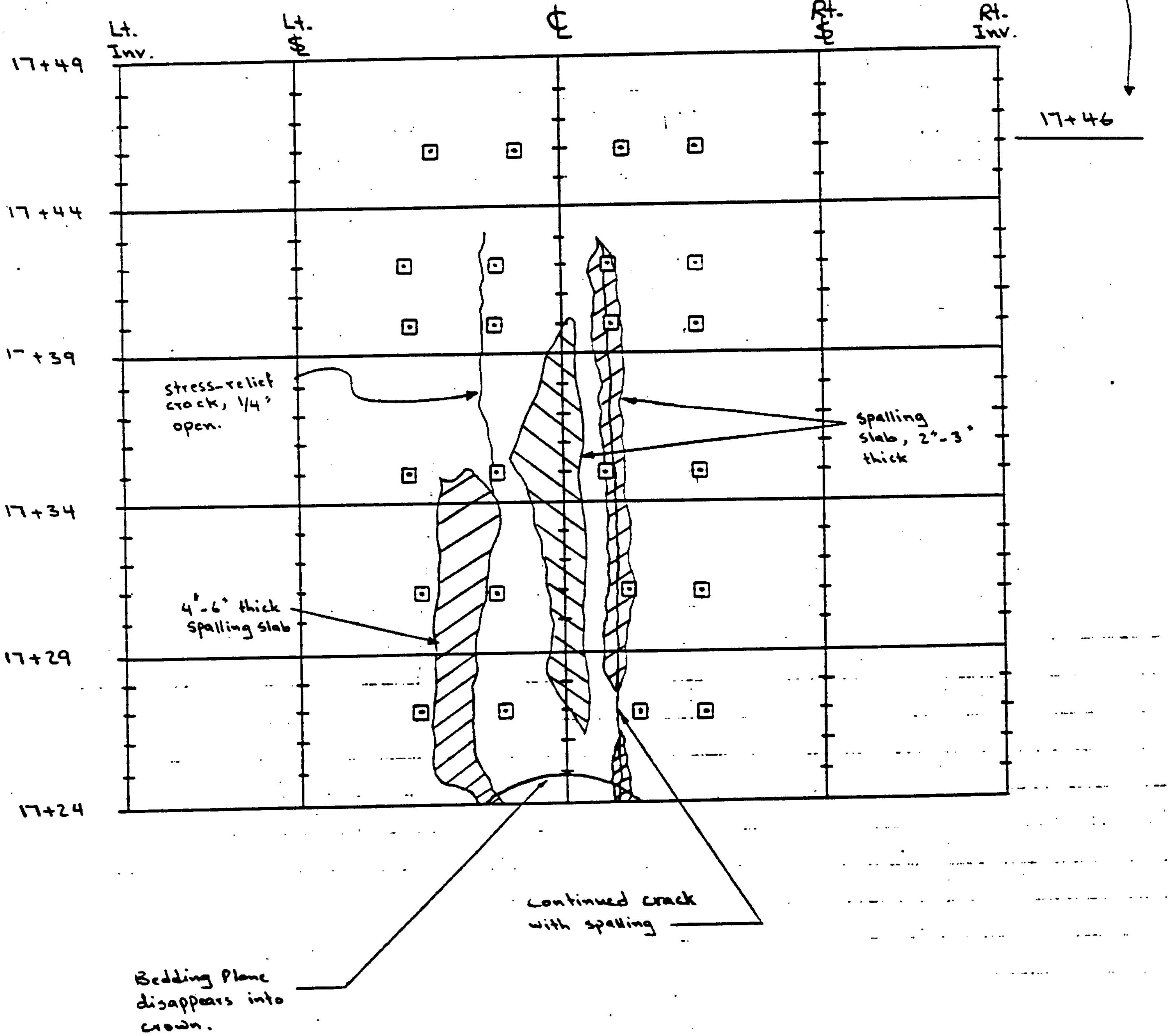
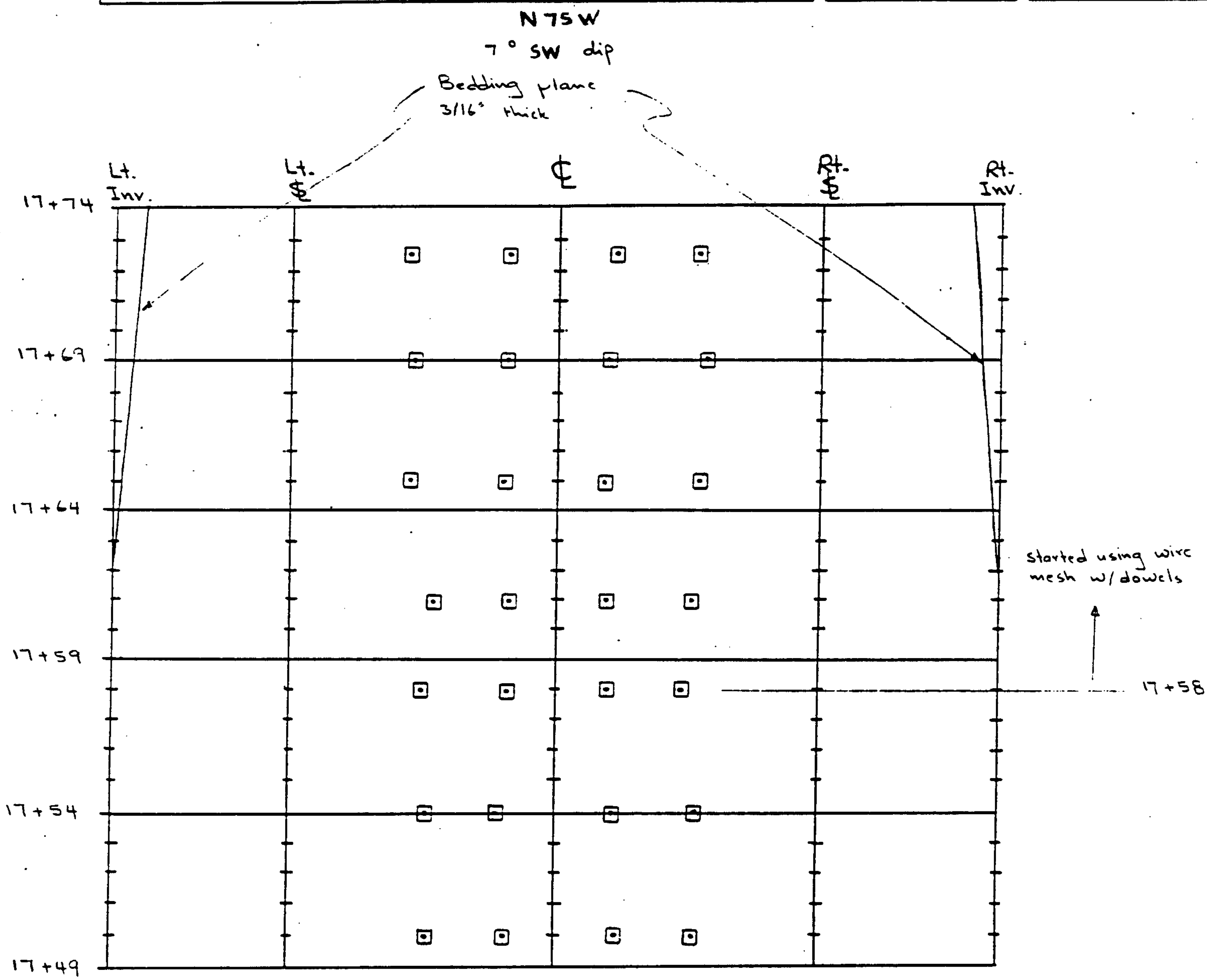
* New Providence Shale started to change color from dark gray to greenish grey with hues of green & silt-brown banding (layers of coloration)



Job No.	No.

LACHEL & Associates, Inc.
Geologists, Engineers

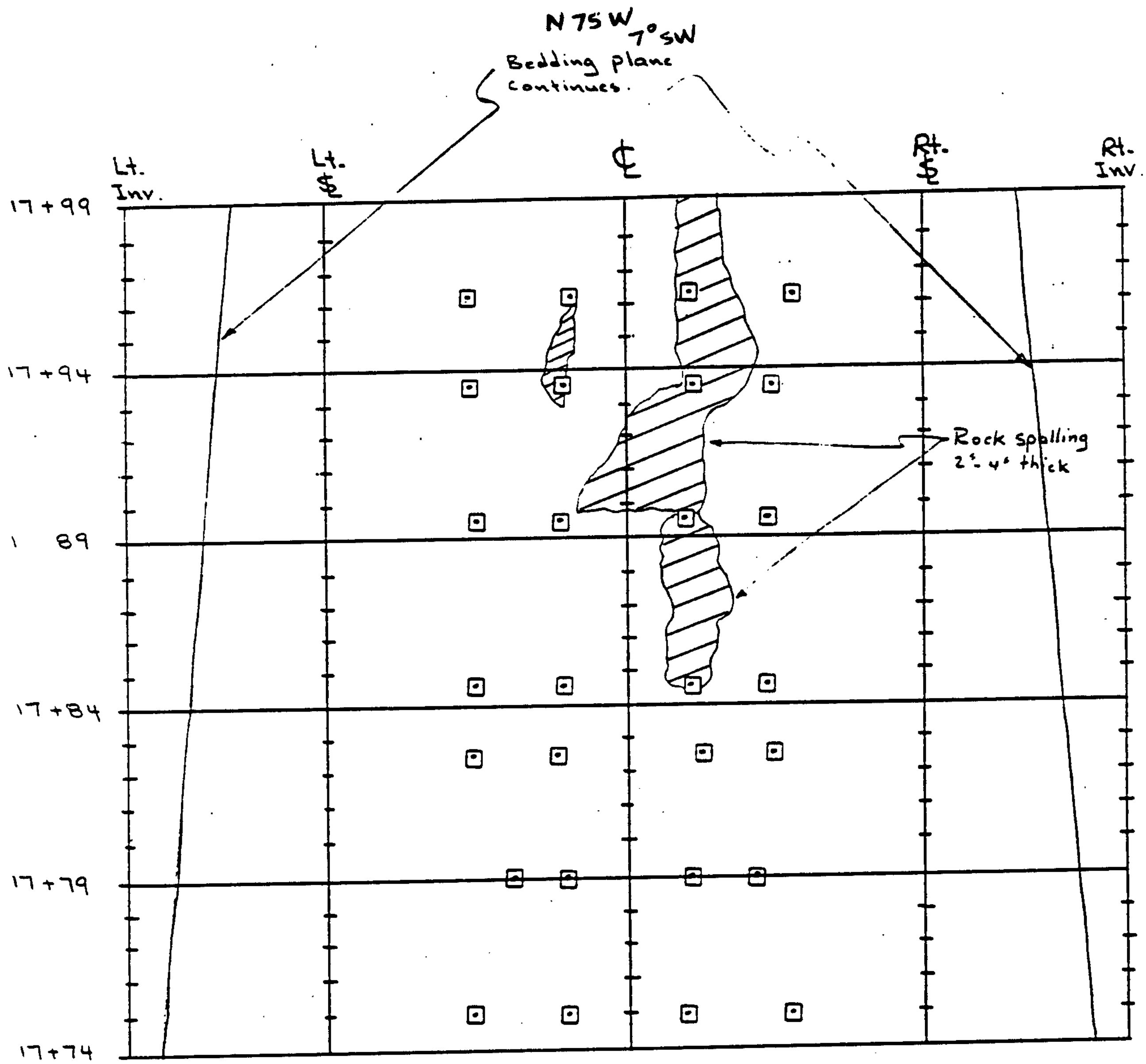
Project UTP		Computed	Date
Subject		Checked	Date
Task		Sheet 68	Of 72



Job No. | No.

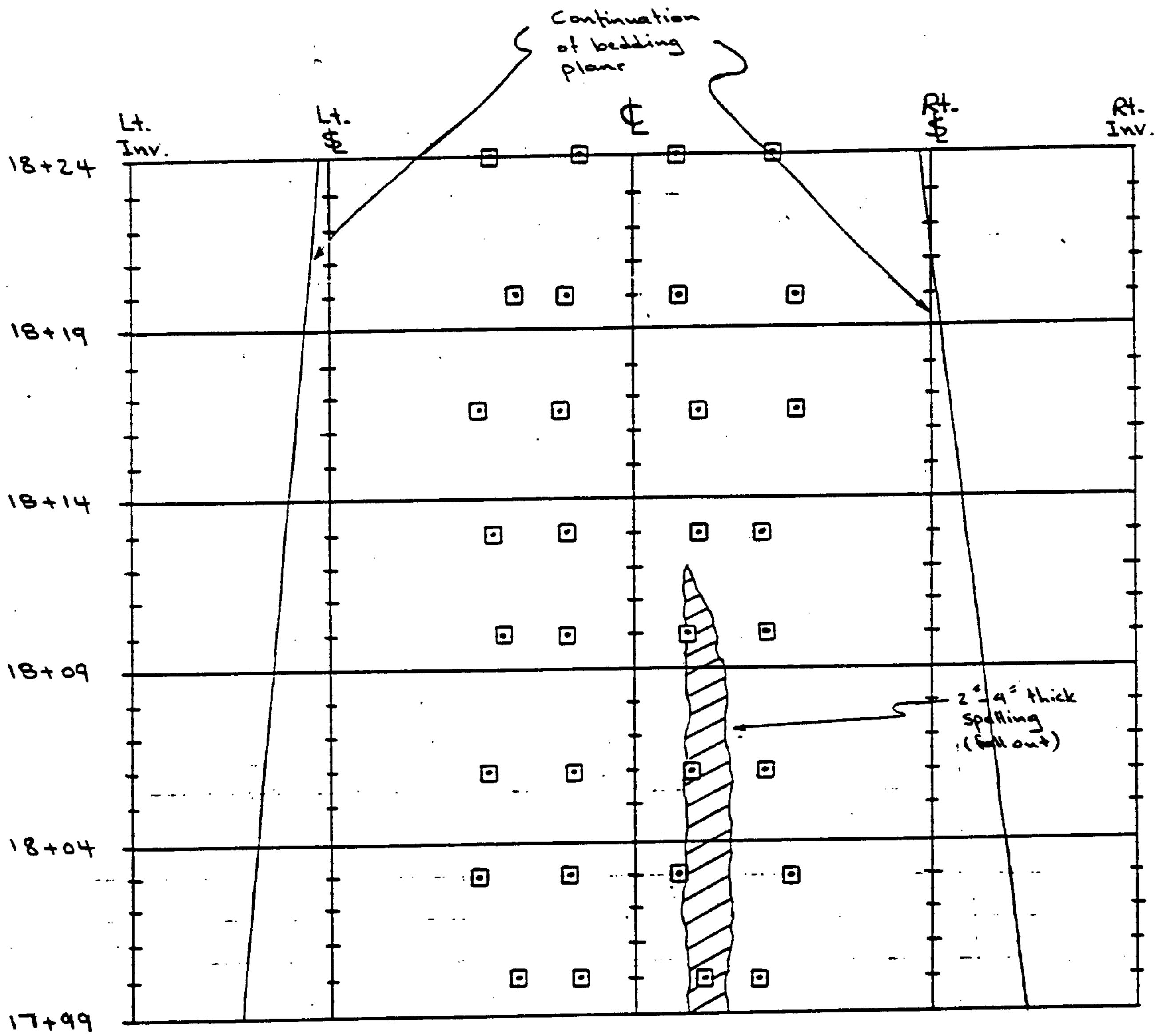
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 69	of 72



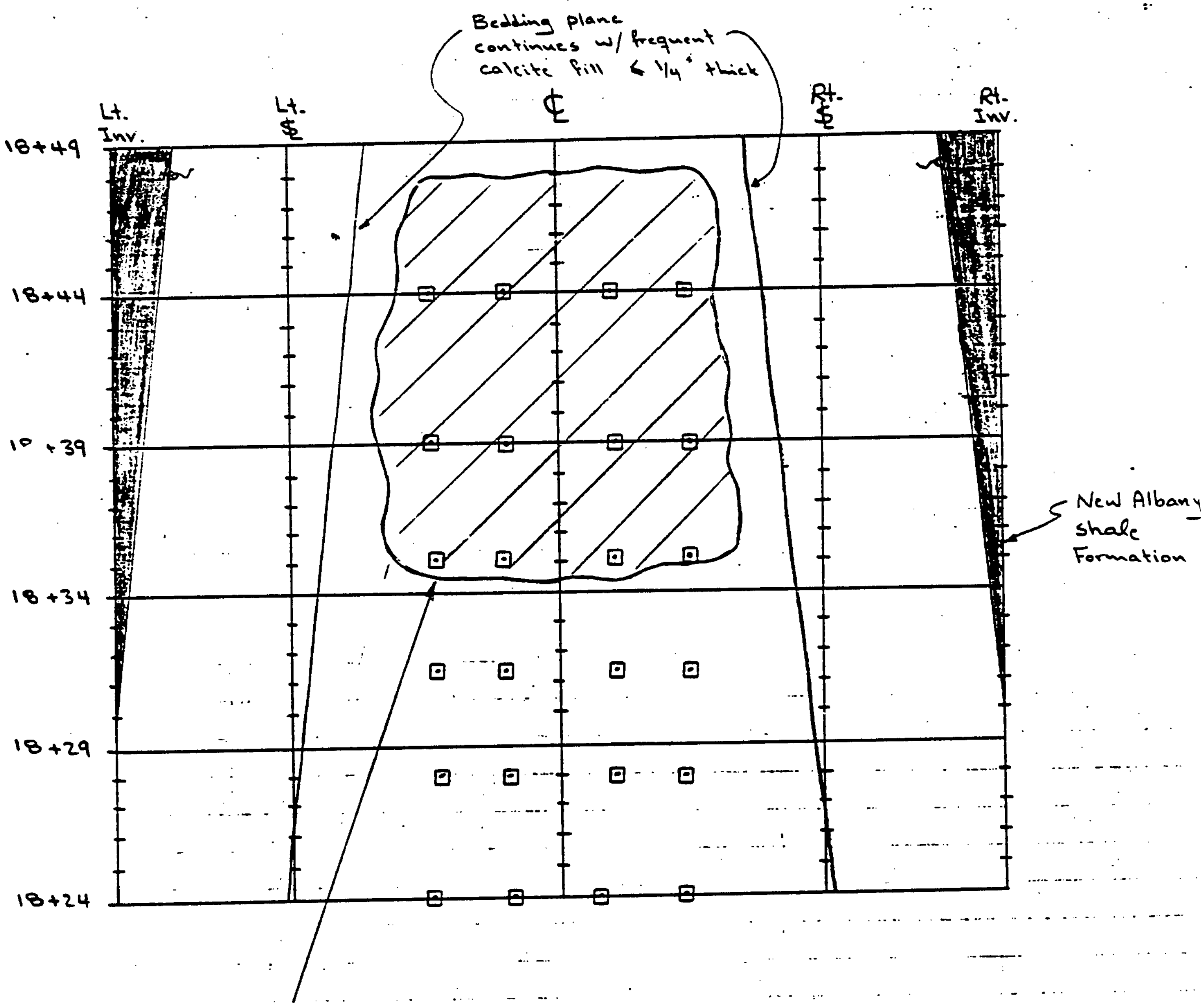
LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 70	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 71	Of 72

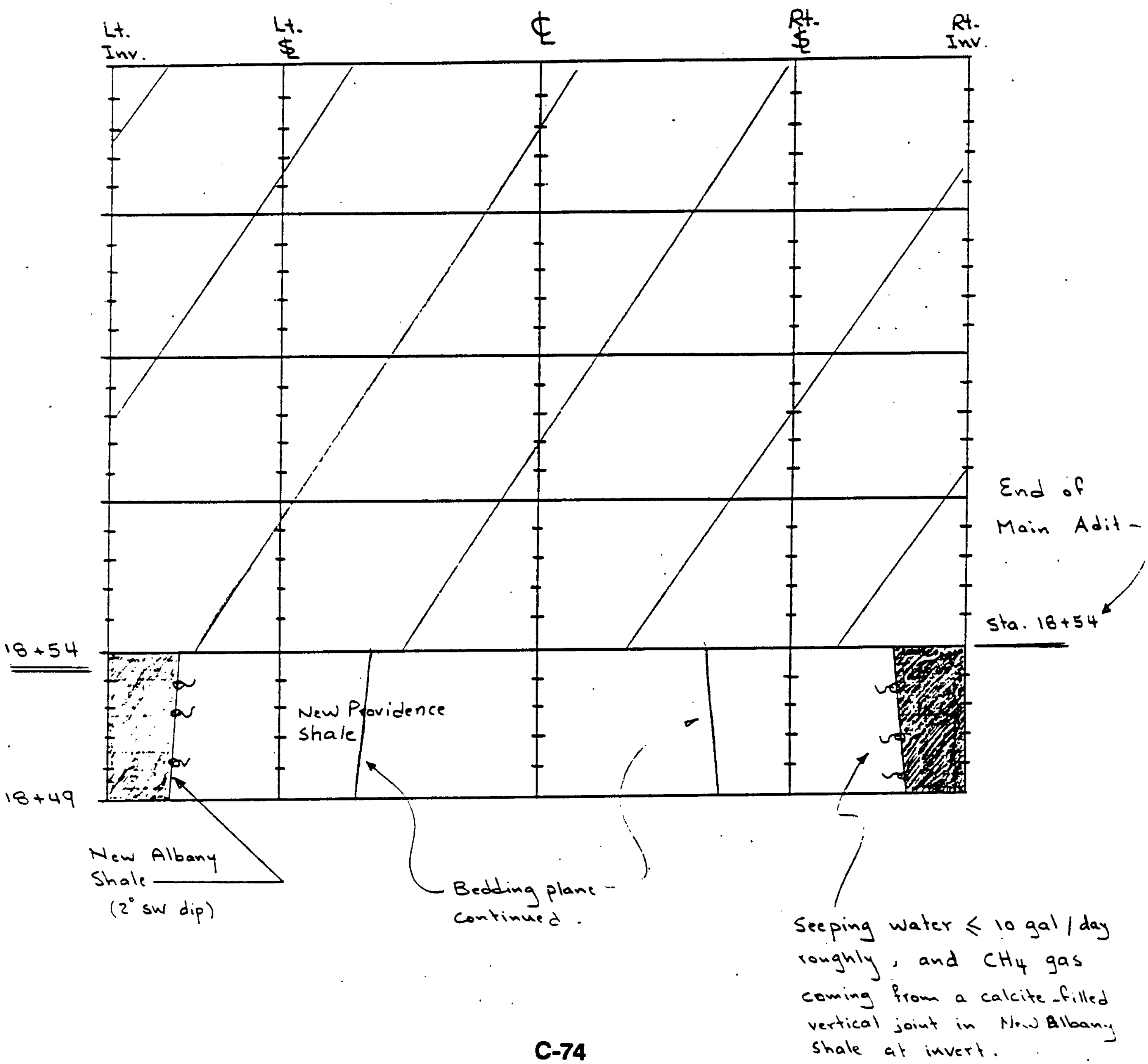


Spalling rock slab, 4"-8" thick fell due to long period of shale exposure to air (> 7 days) without shotcreting, Resulted in flat crown.

Job No. | No.

LACHEL & Associates, Inc.
Geologists, Engineers

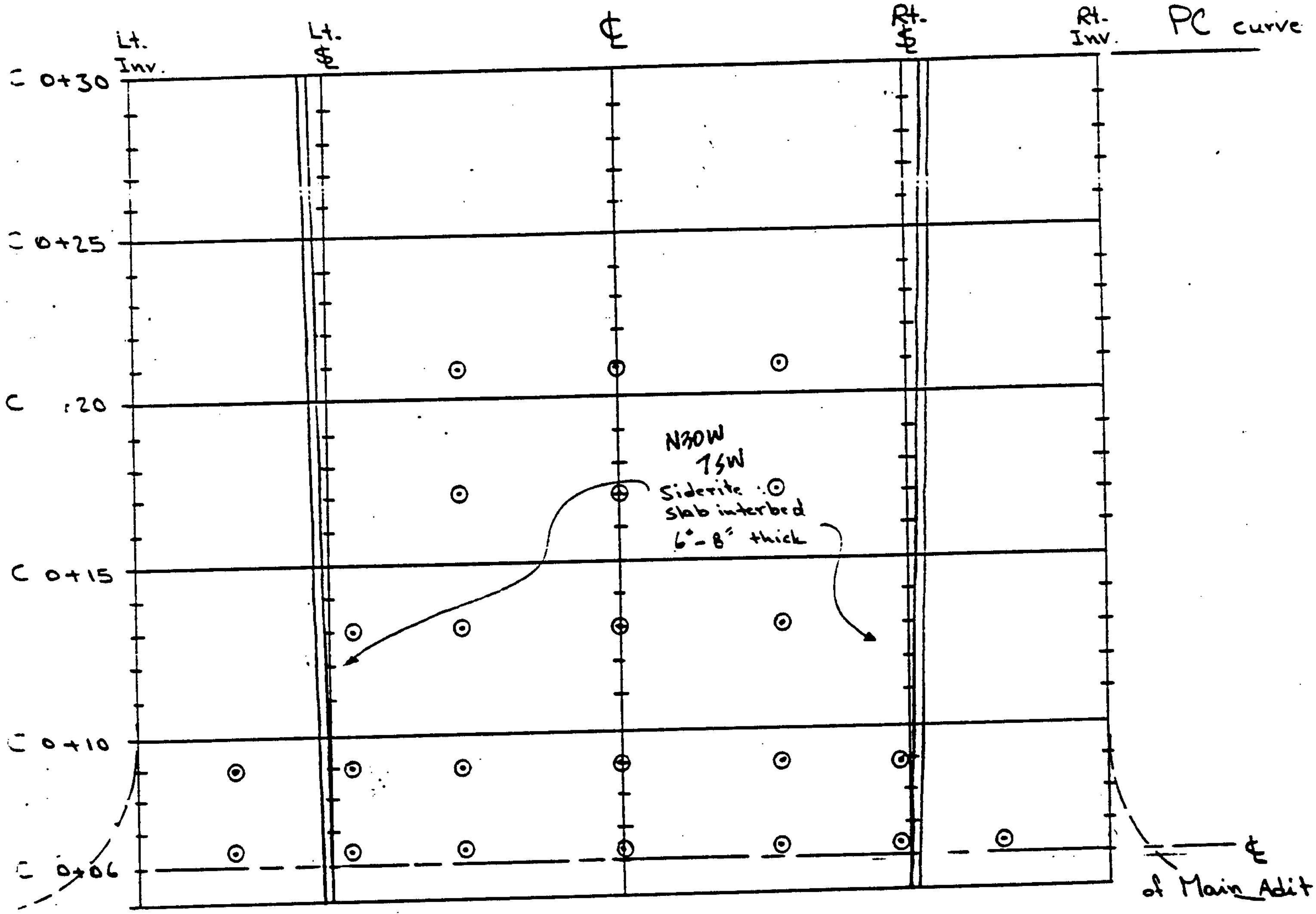
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 72	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Geological Mapping of Calib. Adit	Checked	Date
Task Rock Type: New Providence shale	Sheet 1	Of 21

Massive Rock

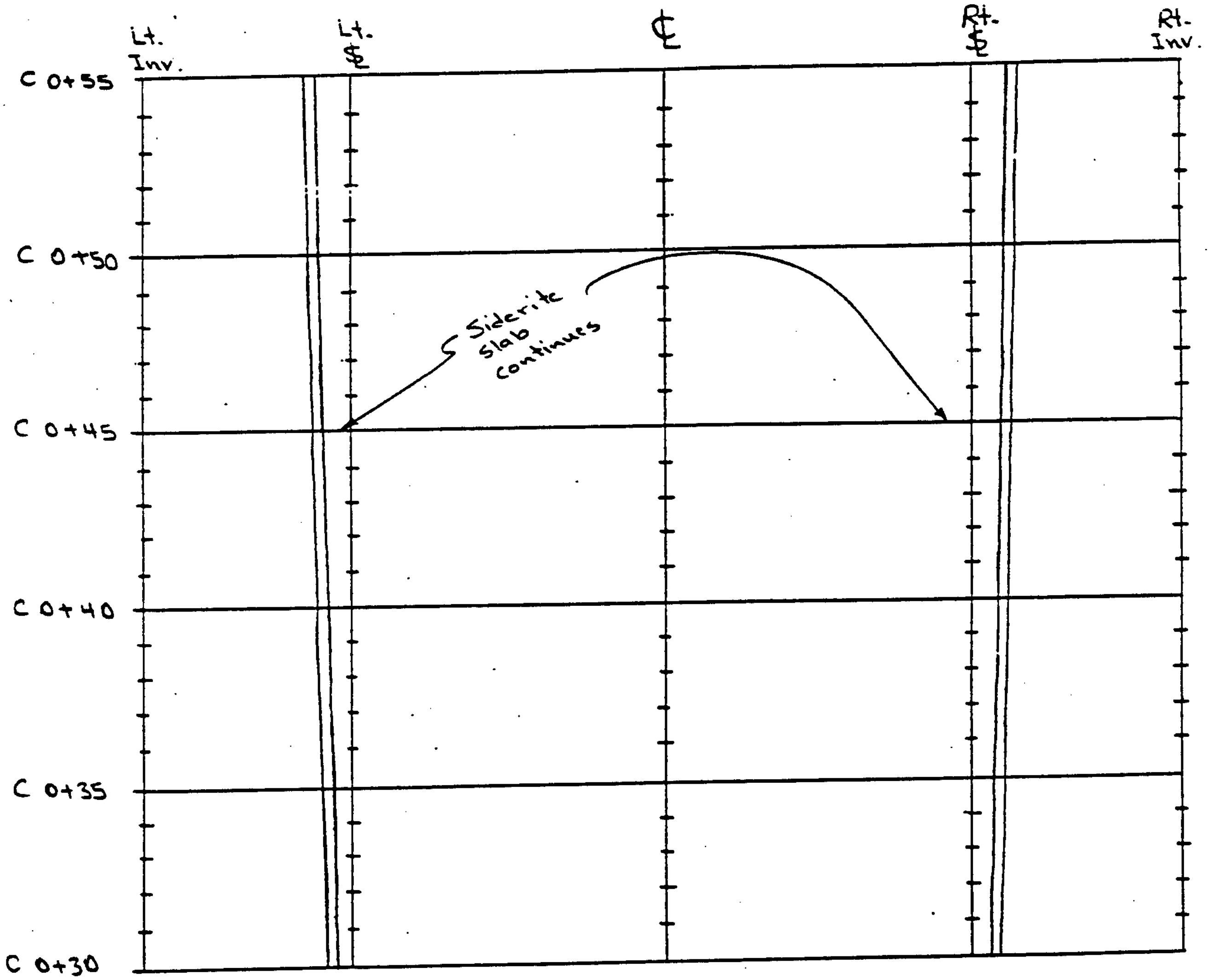


* Start station of Calibration Adit is C 0+00 @ center of Main Adit @ Sta. 16+00

* Cal. Adit has a curve ; Curve #2 PC Sta. C 0+30
PT Sta. C 1+34.61

LACHEL & Associates, Inc.
Geologists, Engineers

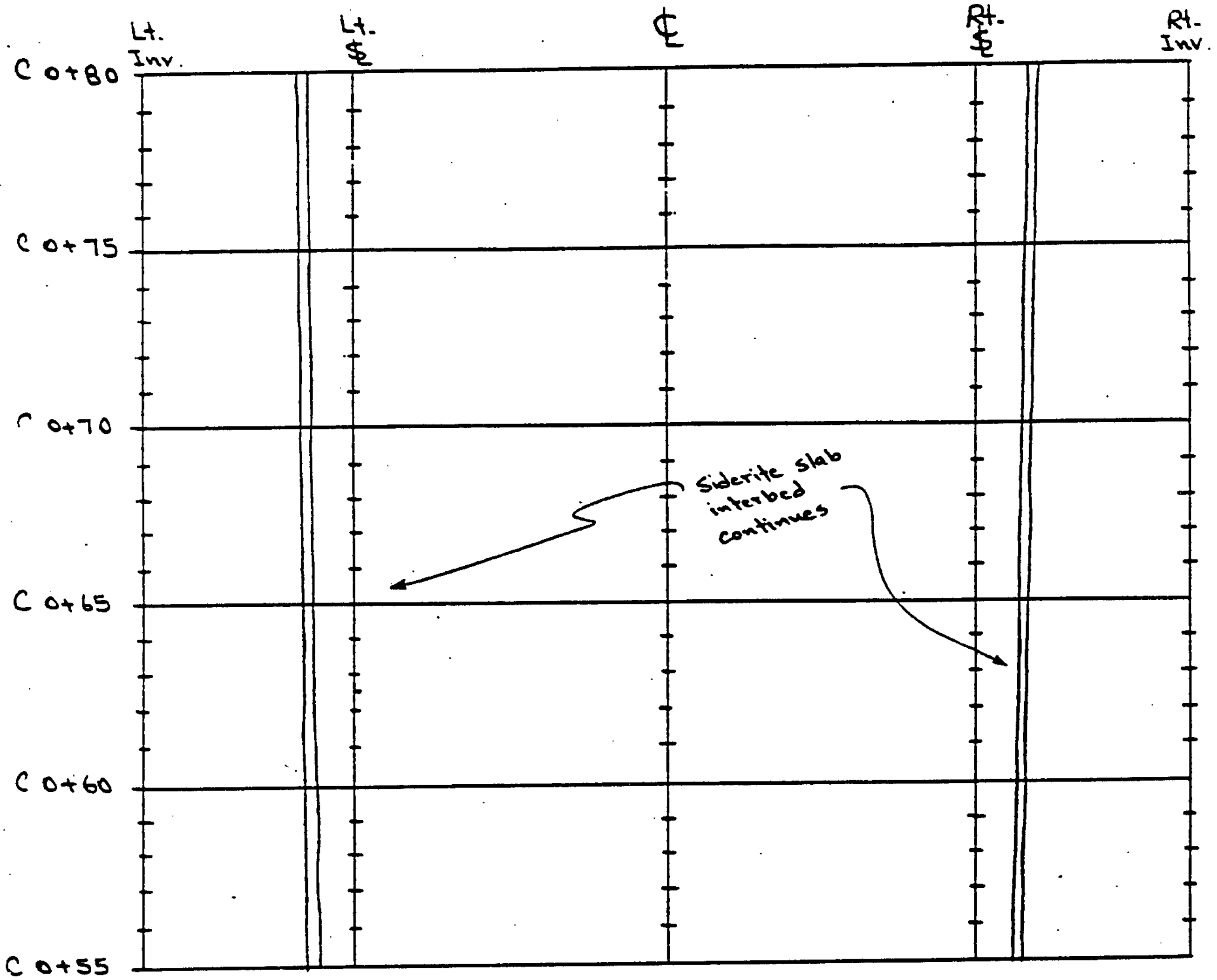
Project UTP	Computed	Date
Subject Geo. Mapping - Cal. Adit	Checked	Date
Task	Sheet 2	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

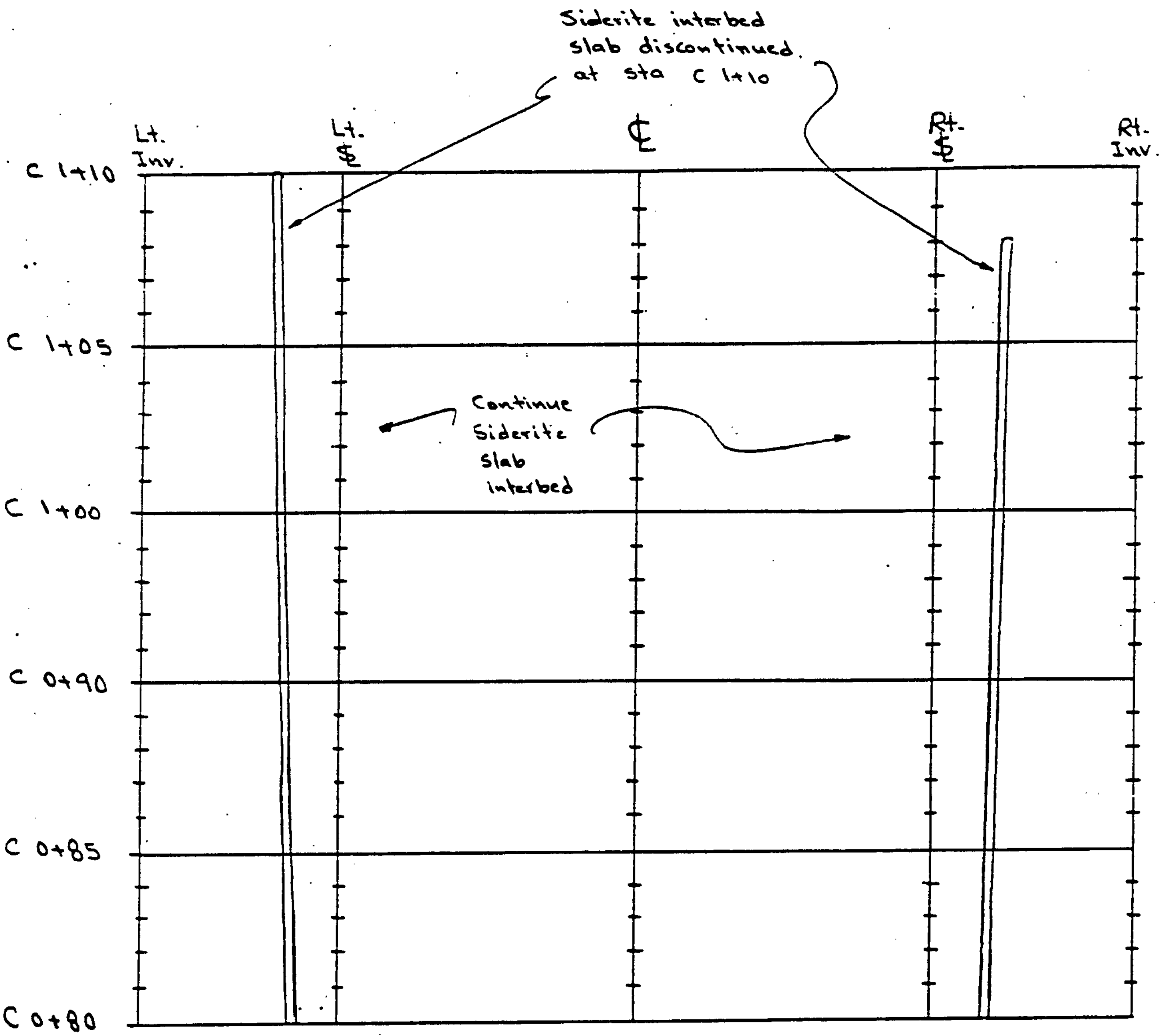
Project UTP	Computed	Date
Subject Col. Adit	Checked	Date
Task	Sheet 3	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

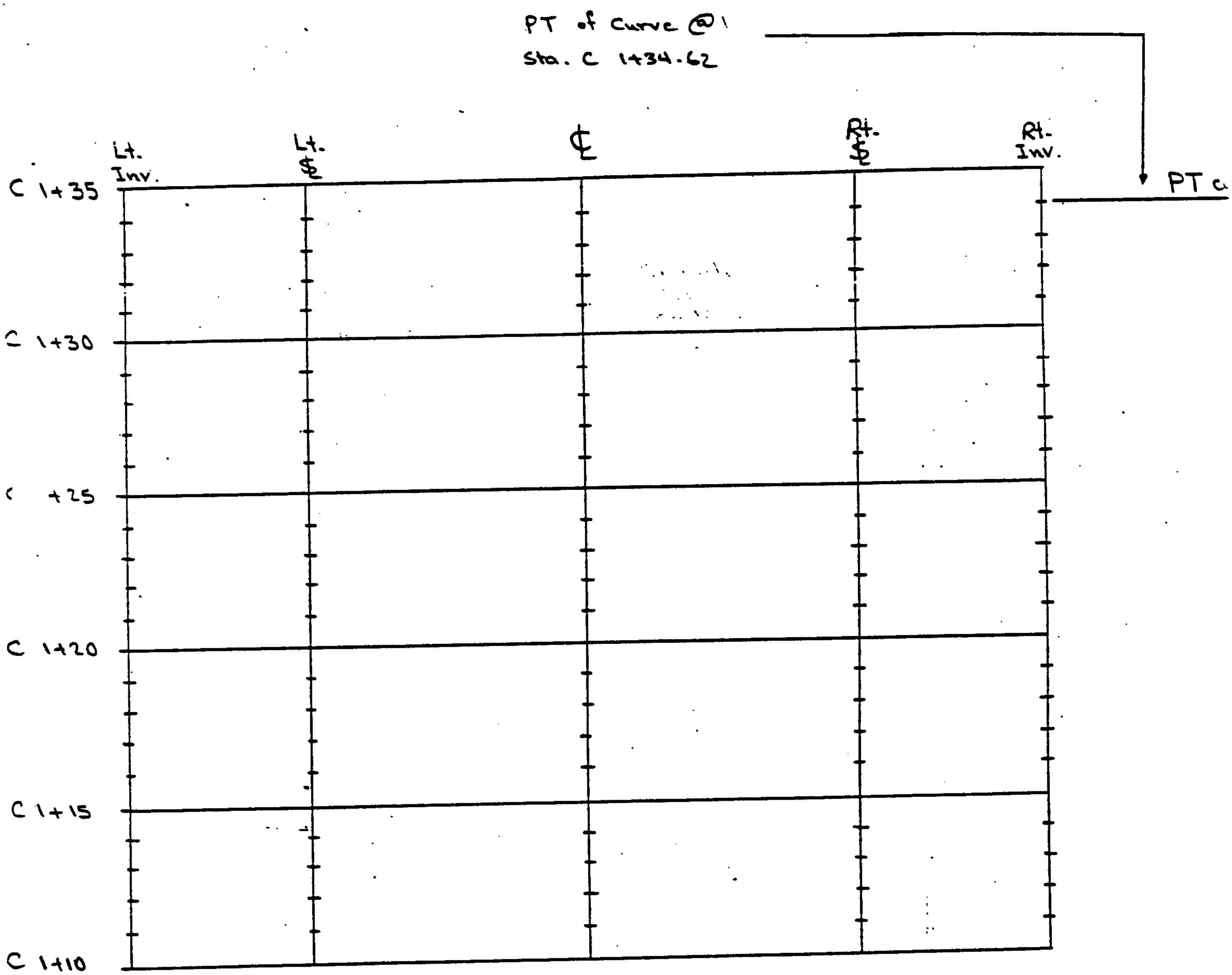
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 4	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

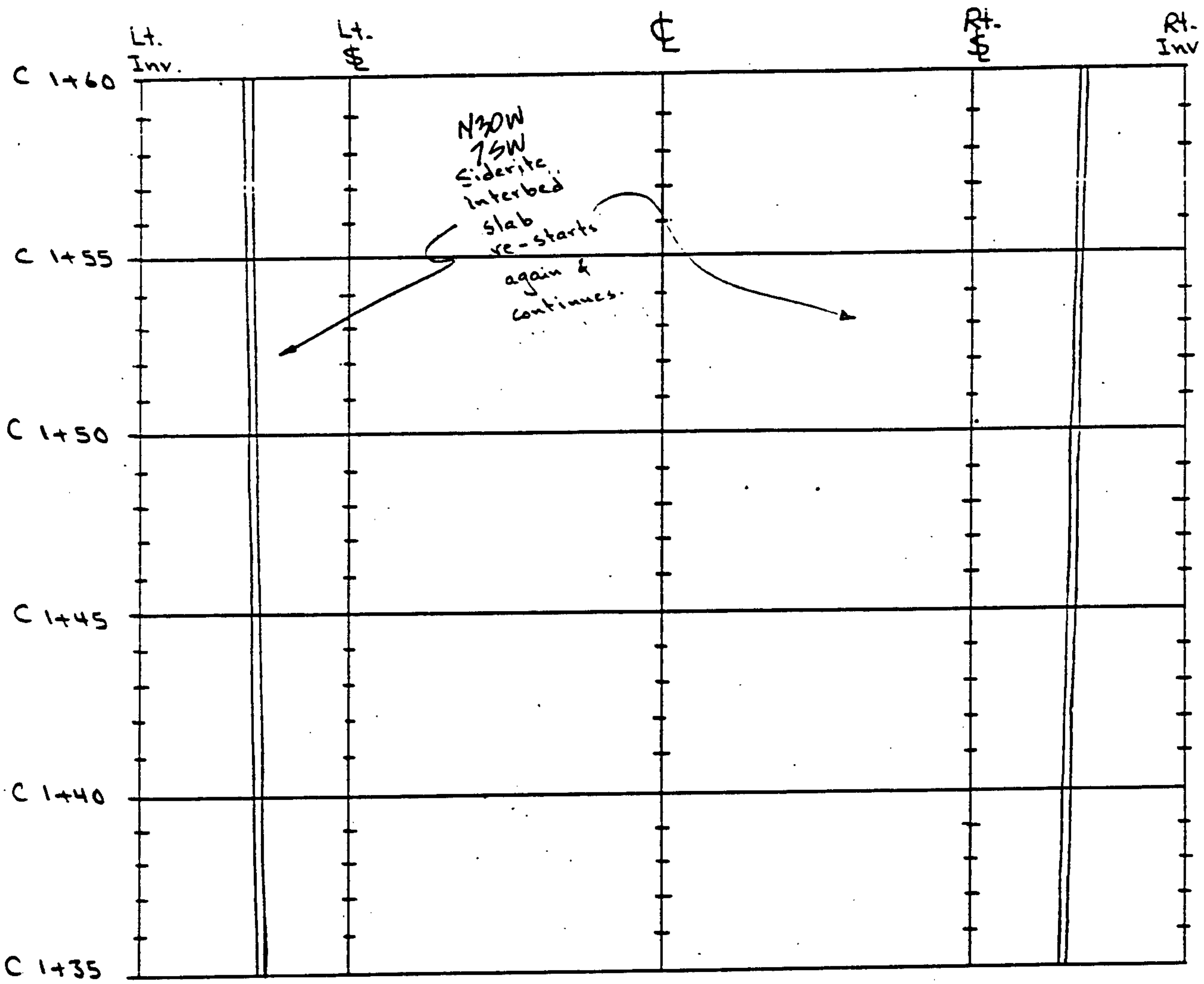
Project UTP	Computed	Date
Subject Col. Adit	Checked	Date
~~Task~~ Rock: New Providence Shale	Sheet 5	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 6	Of 21



Massive Rock

* Sta. C 1+34.62 – Sta. C 5+24 (End of Cal. Adit)
Orientation of Cal. Adit = 335° (Running Parallel to Main Adit)

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP

Subject Cal. Adit

Task

Computed

Date

Checked

Date

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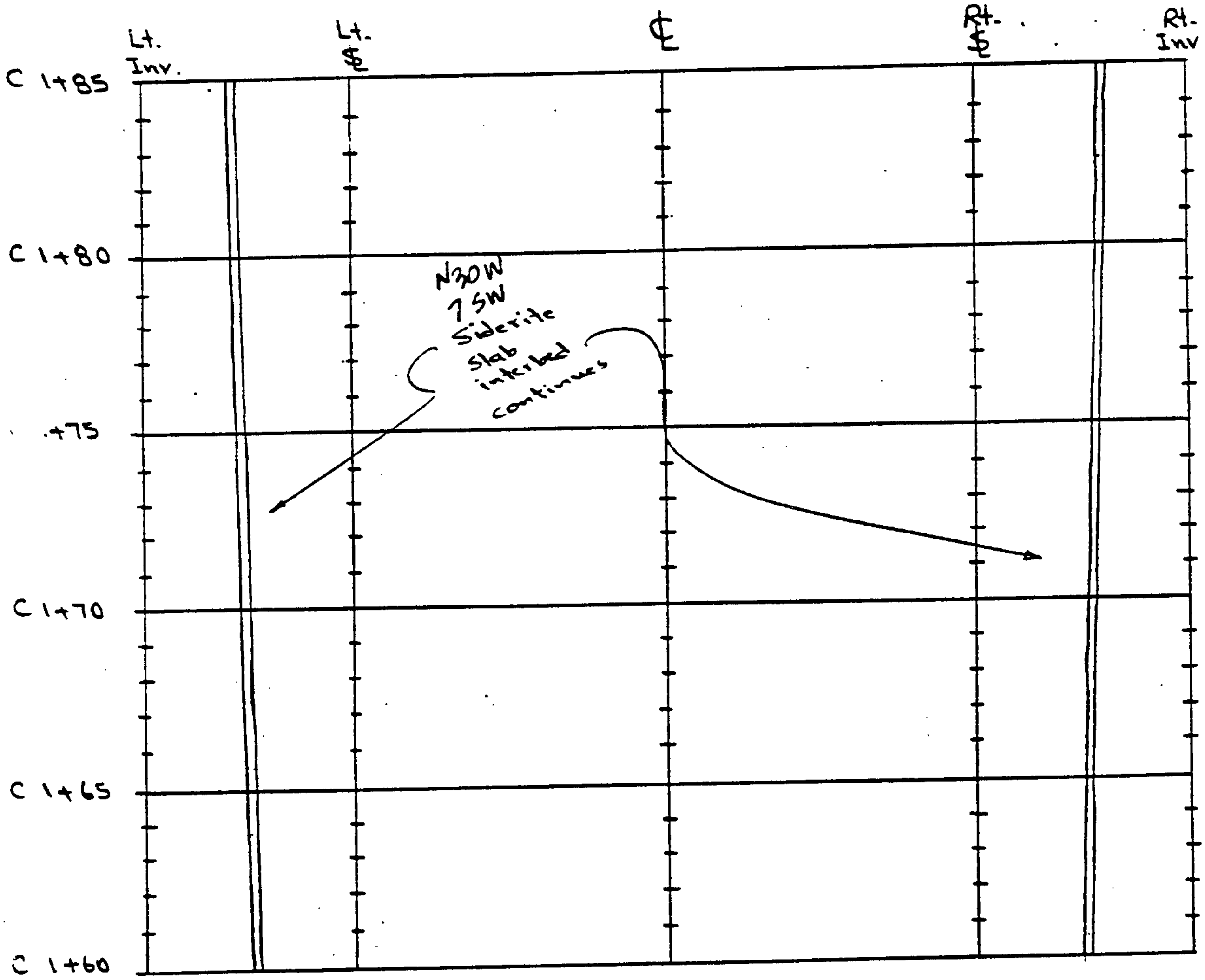
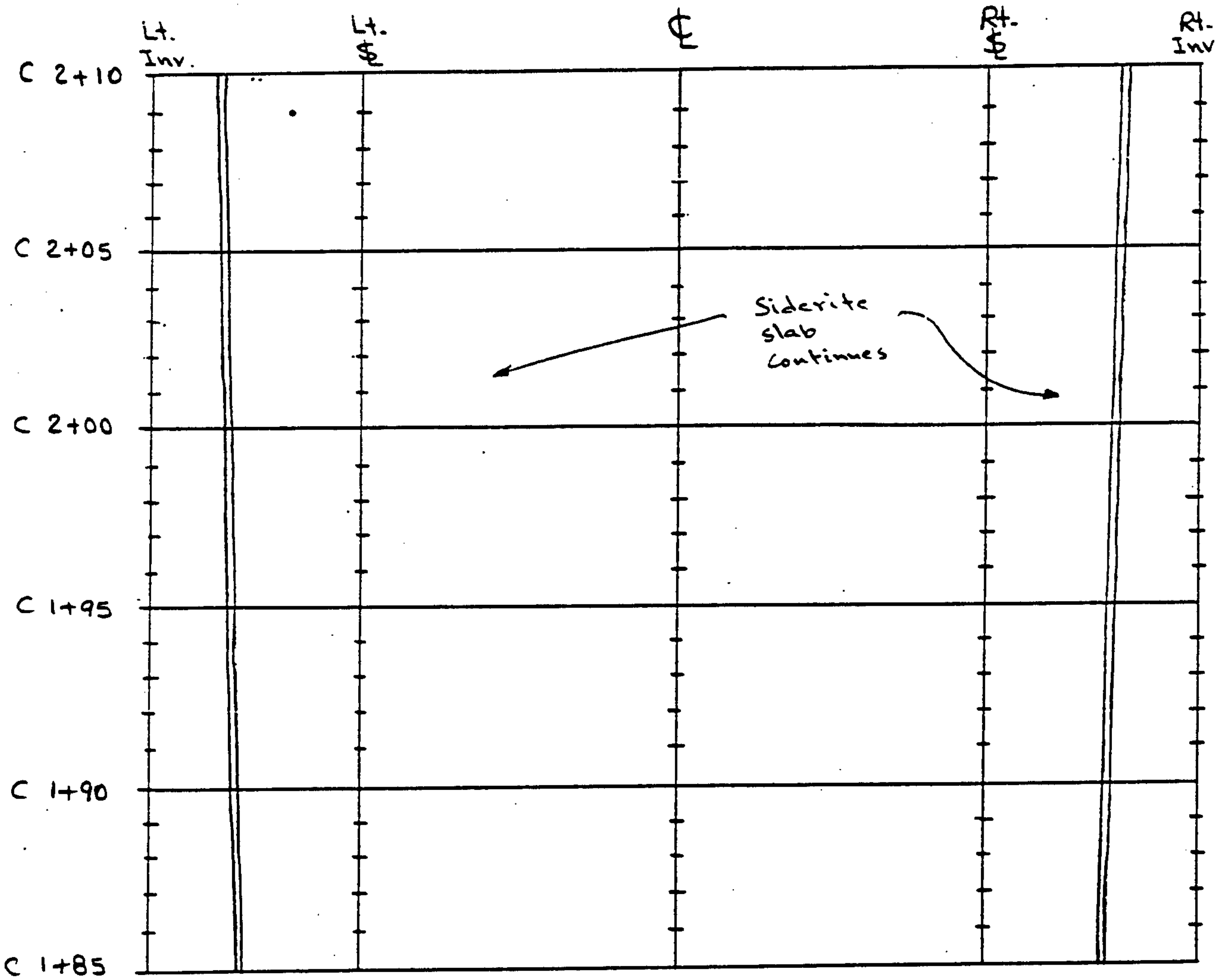


Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 8	Of 21

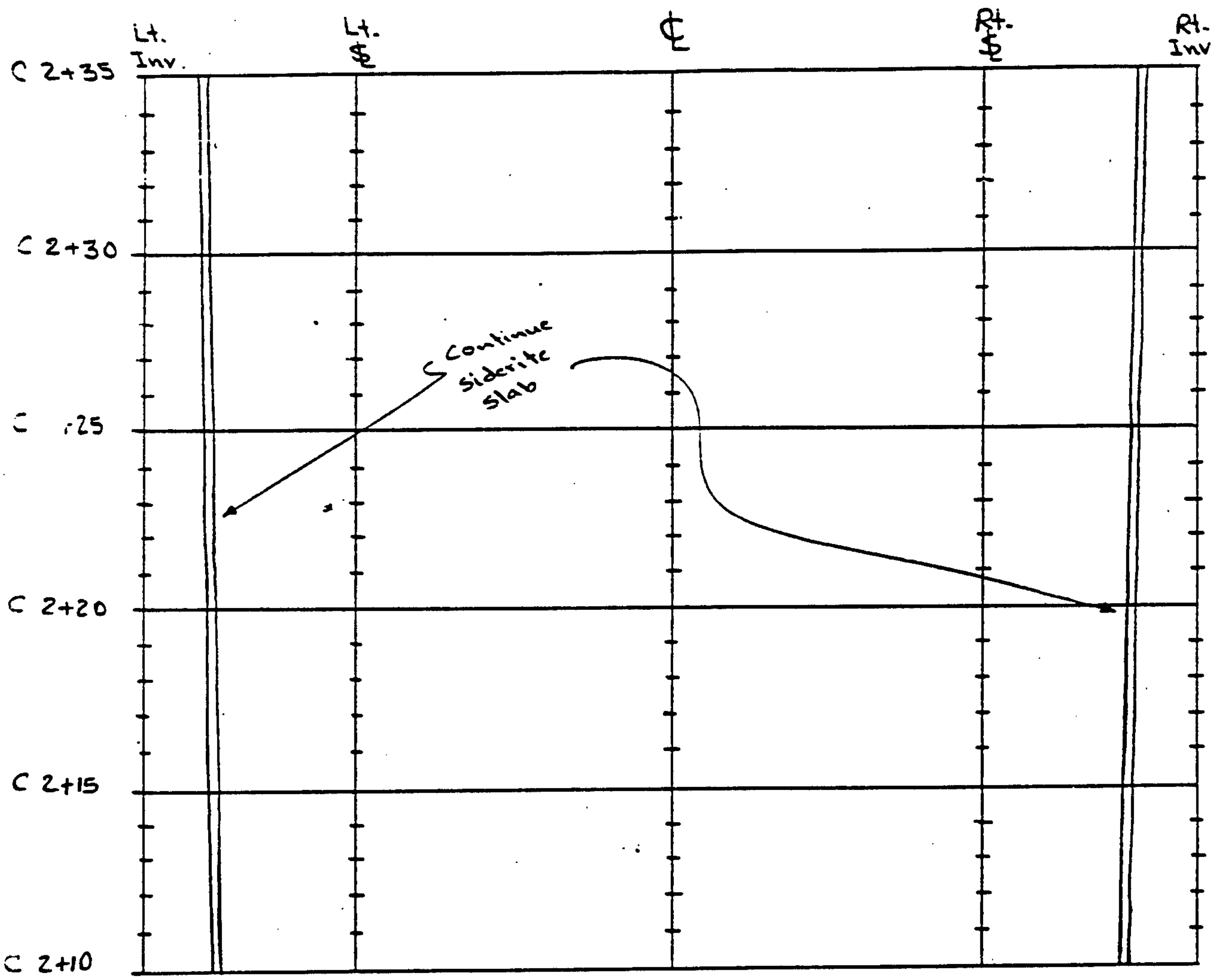


Massive Rock

Job No. | No

LACHEL & Associates, Inc.
Geologists, Engineers

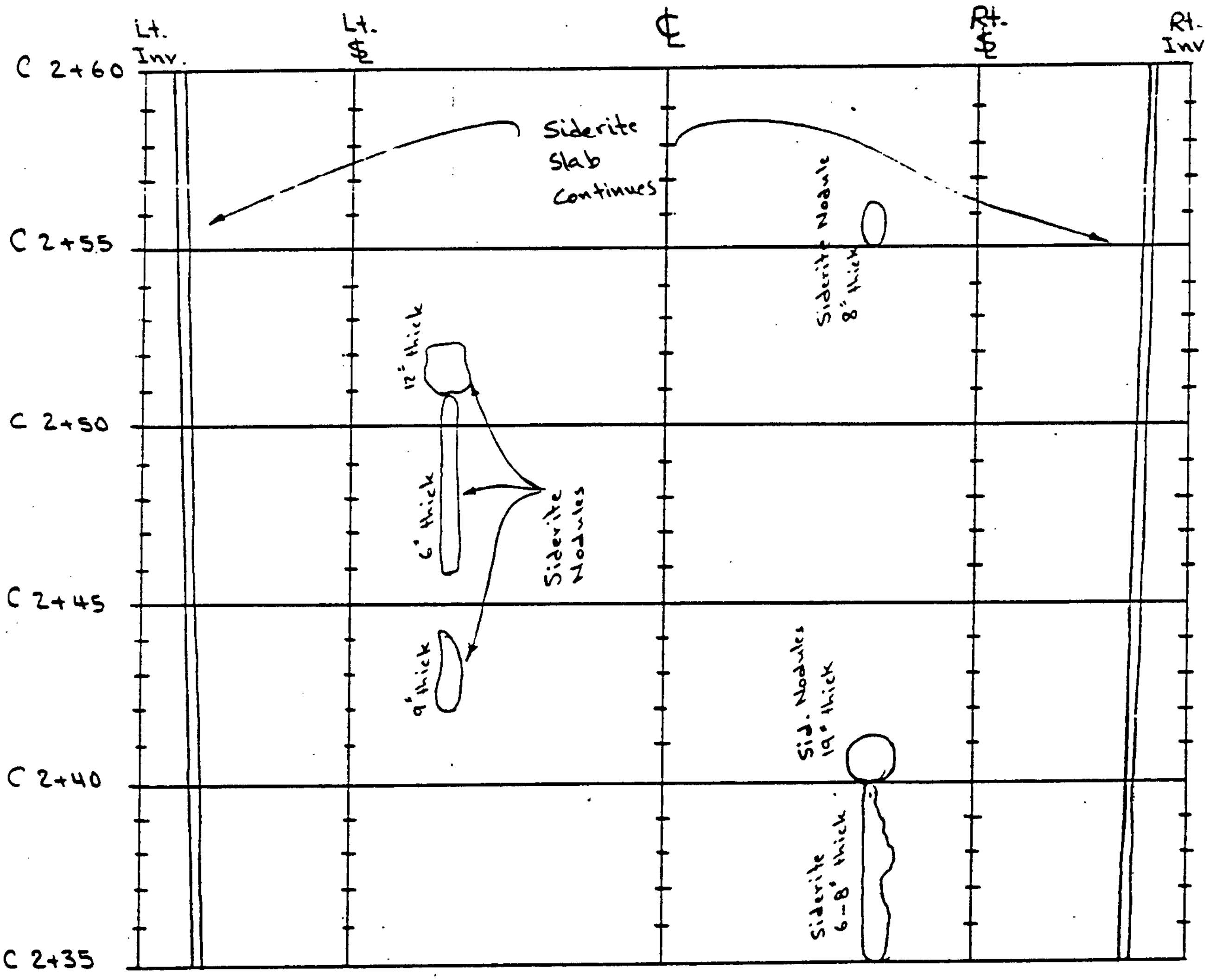
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 9	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

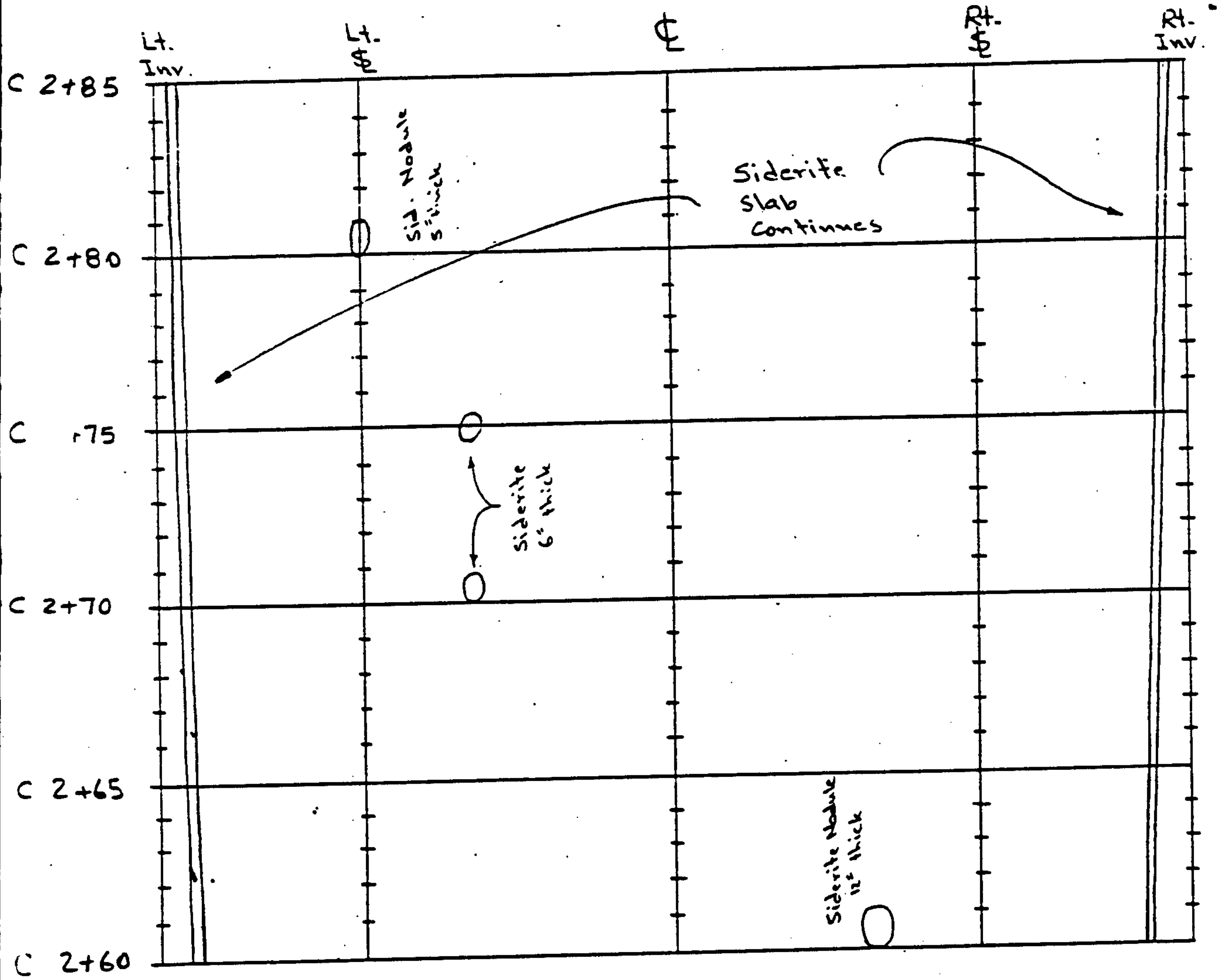
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 10	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

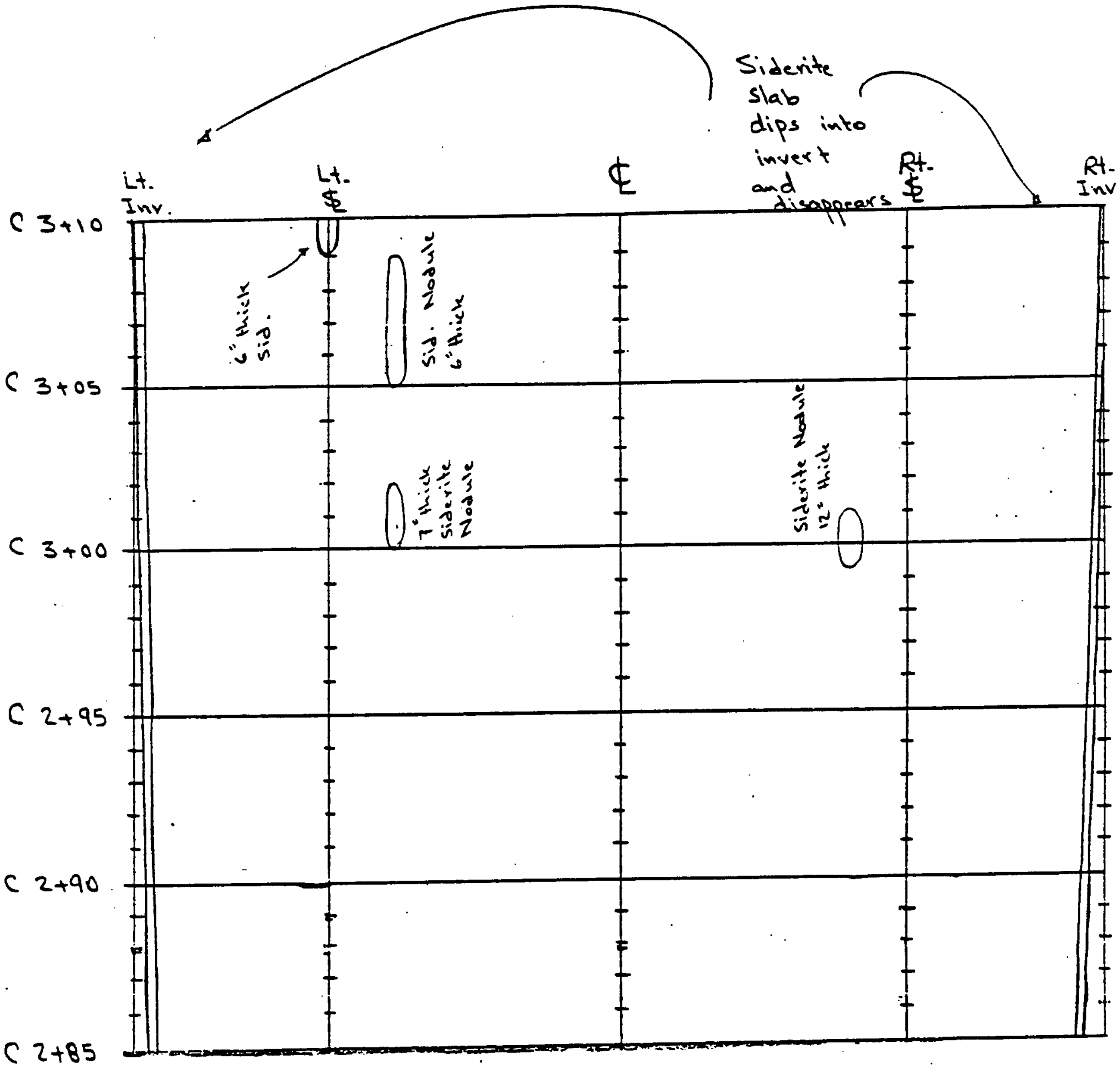
Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 11	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

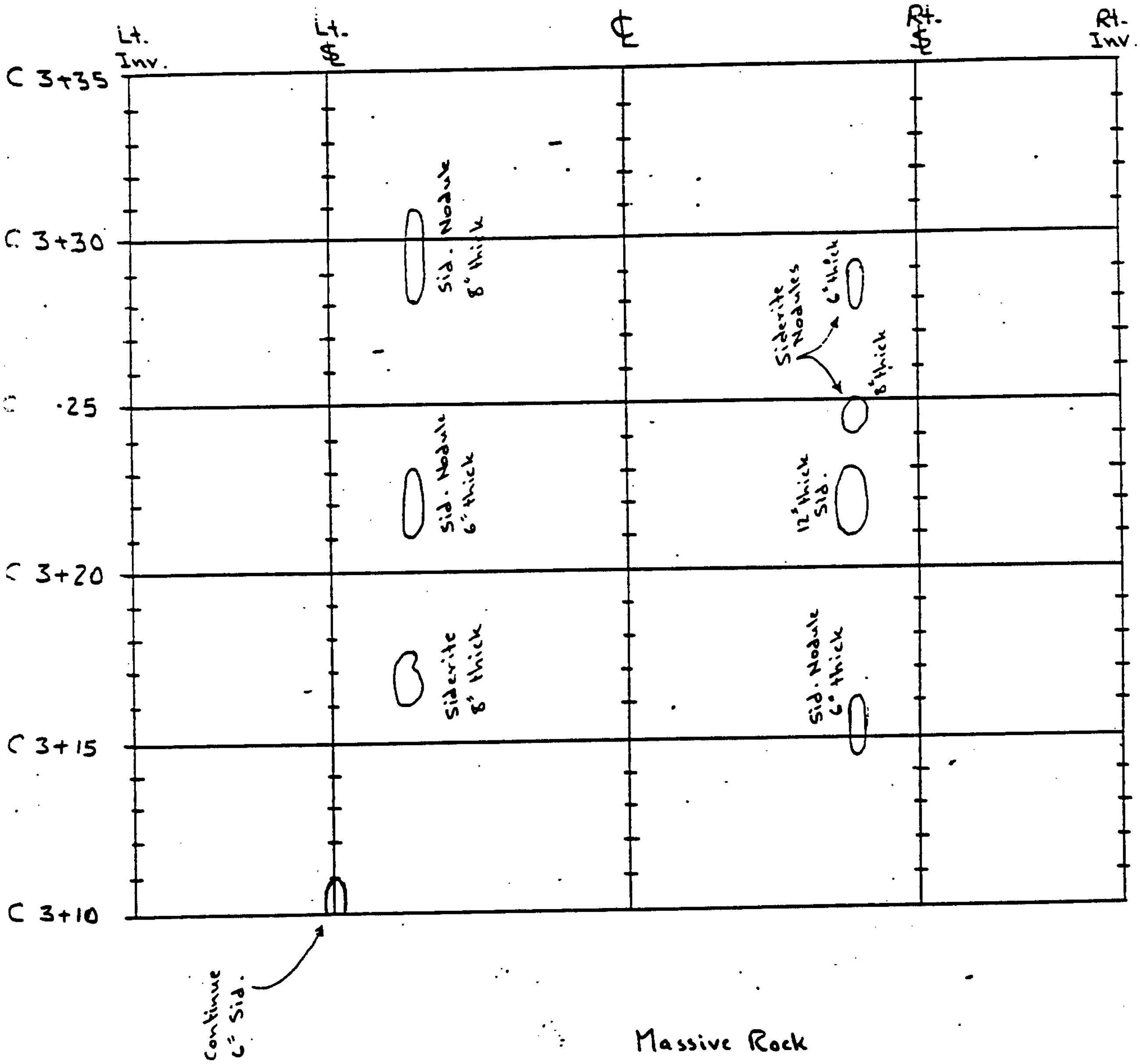
Project UTP	Computed	Date
Subject Col. Adit	Checked	Date
Task	Sheet 12	Of 21

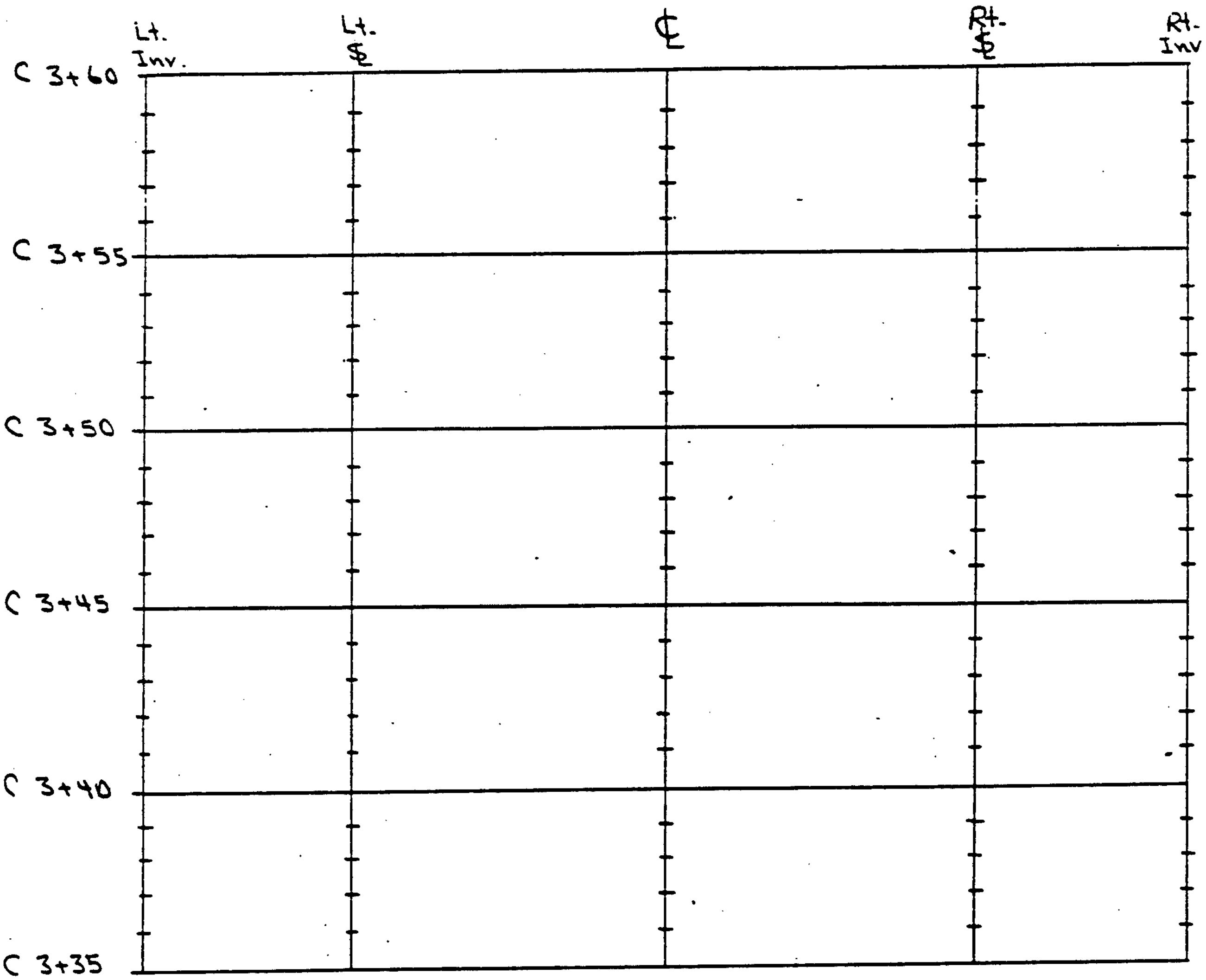


Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP		Computed	Date
Subject		Checked	Date
Task		Sheet 13	Of 21

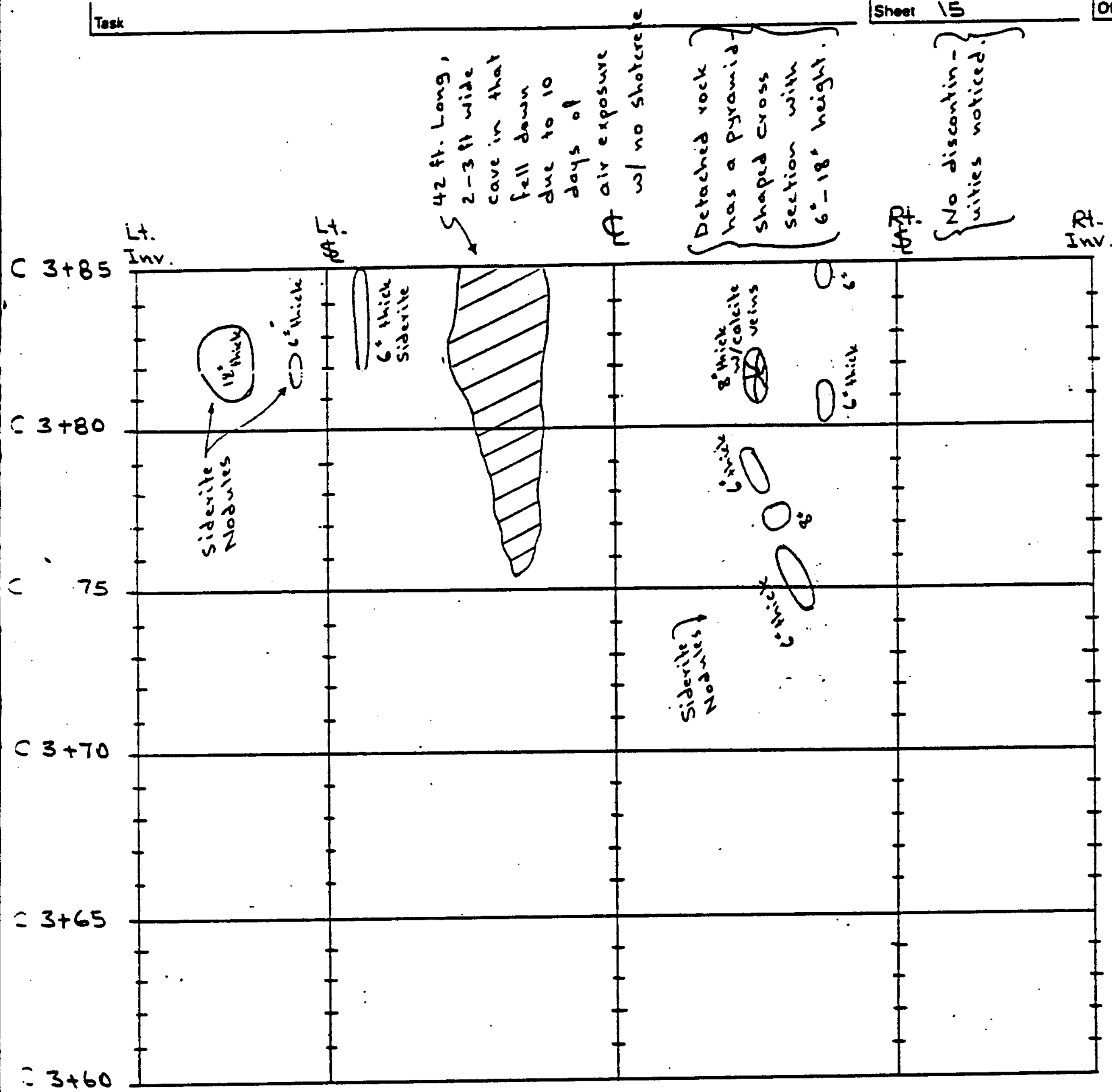




Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP		Computed	Date
Subject Cal. Adit		Checked	Date
Task		Sheet 15	Of 21



* This cave-in occured @ one time. Shotcrete liner was @ Sta. C3+75 and Face @ Sta. C 4+27 when cave-in occured.

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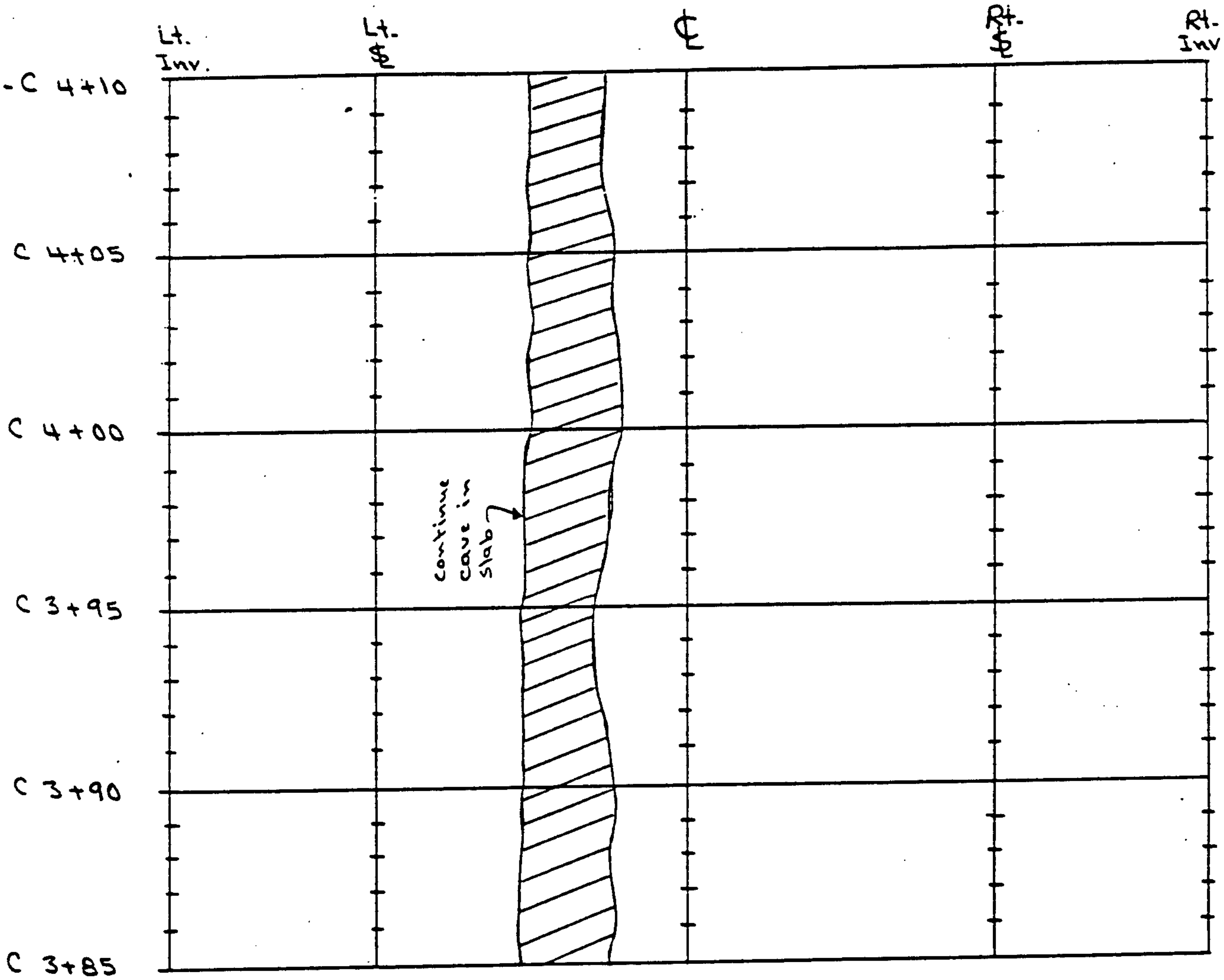
Geologists, Engineers

Project UTP	Computed	Date
Subject Cal. Adit Geo. Mapping	Checked	Date
Task	Sheet 16	Of 21



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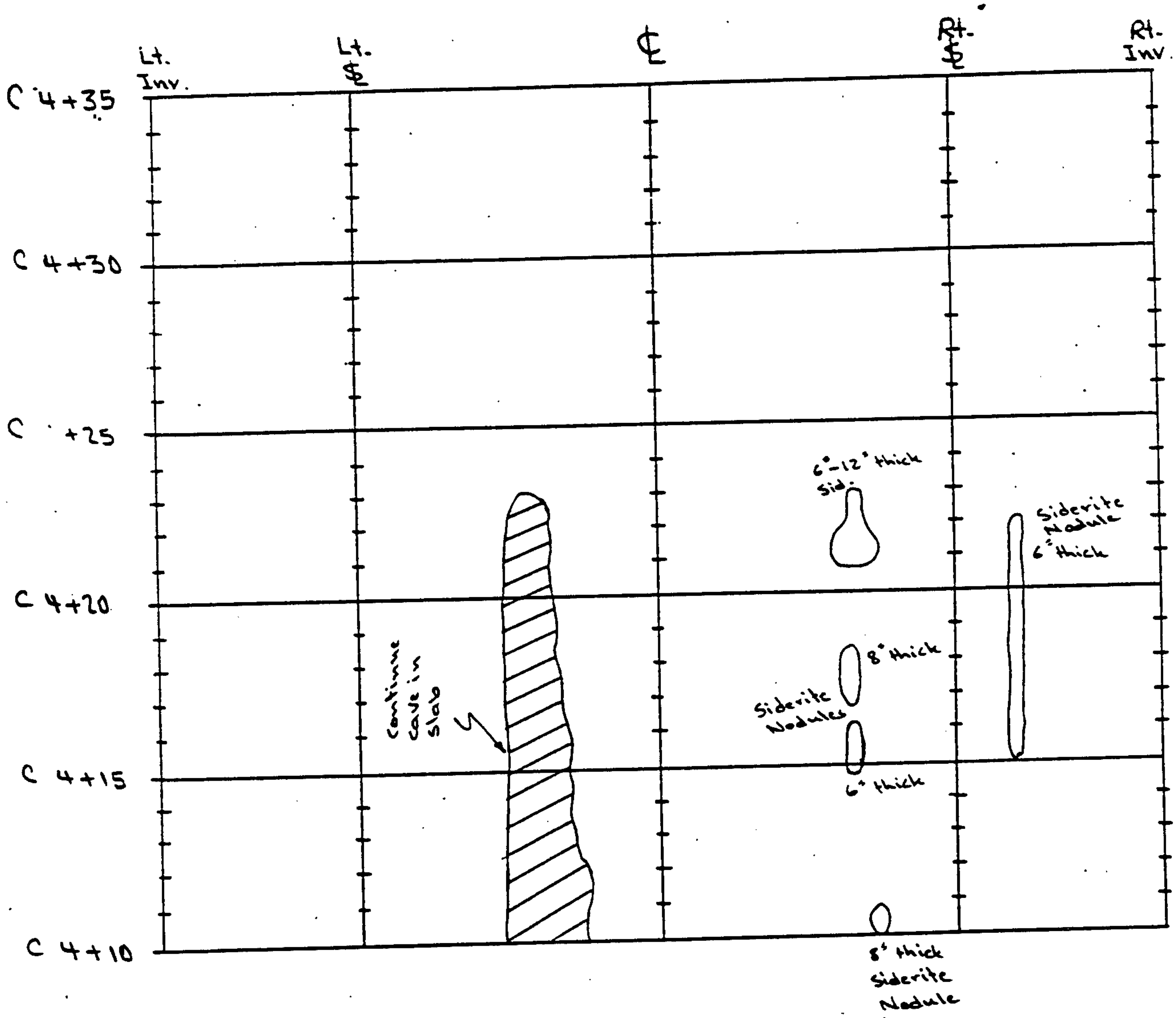
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 17	Of 21



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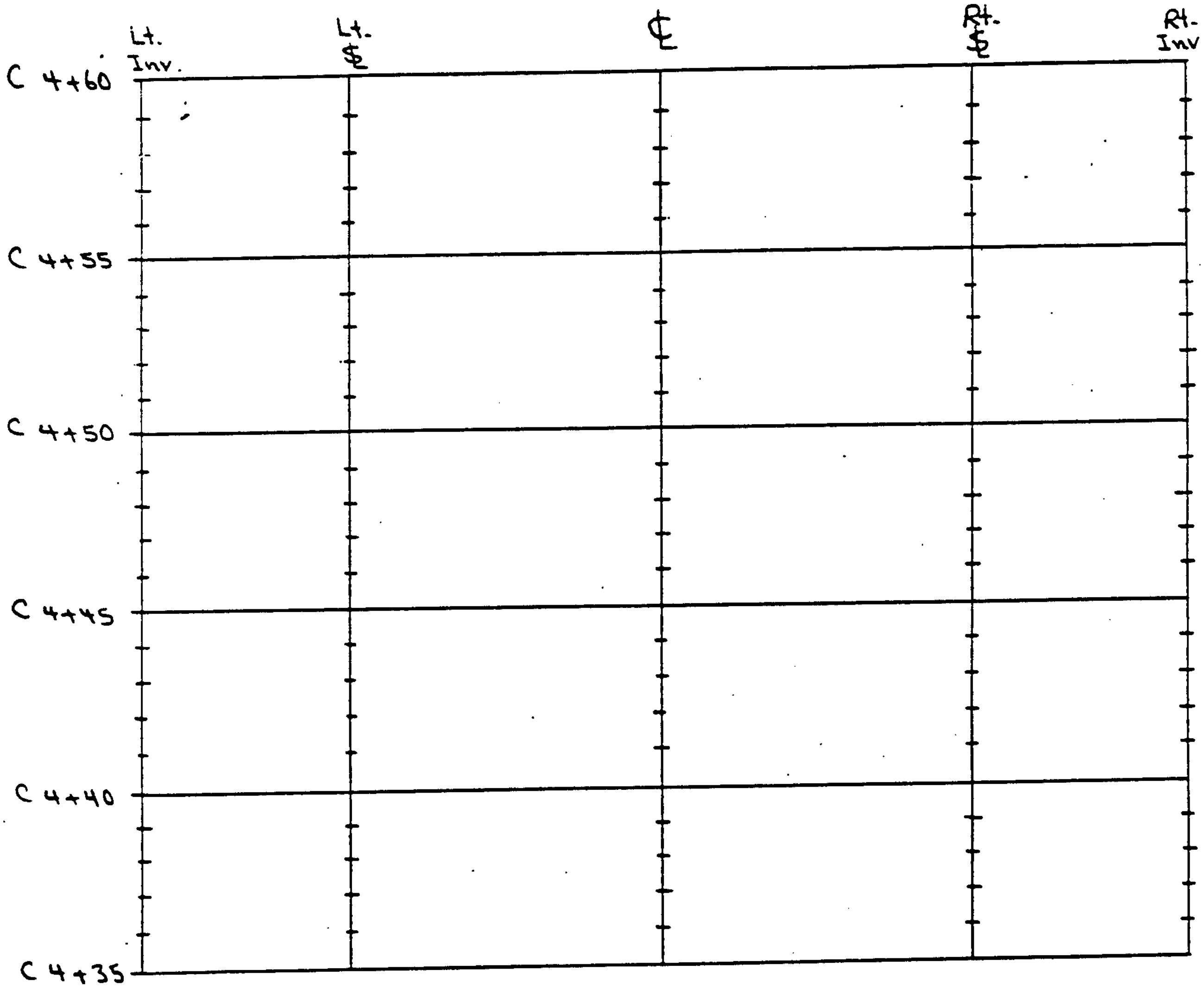
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 18	Of 21



Massive Rock

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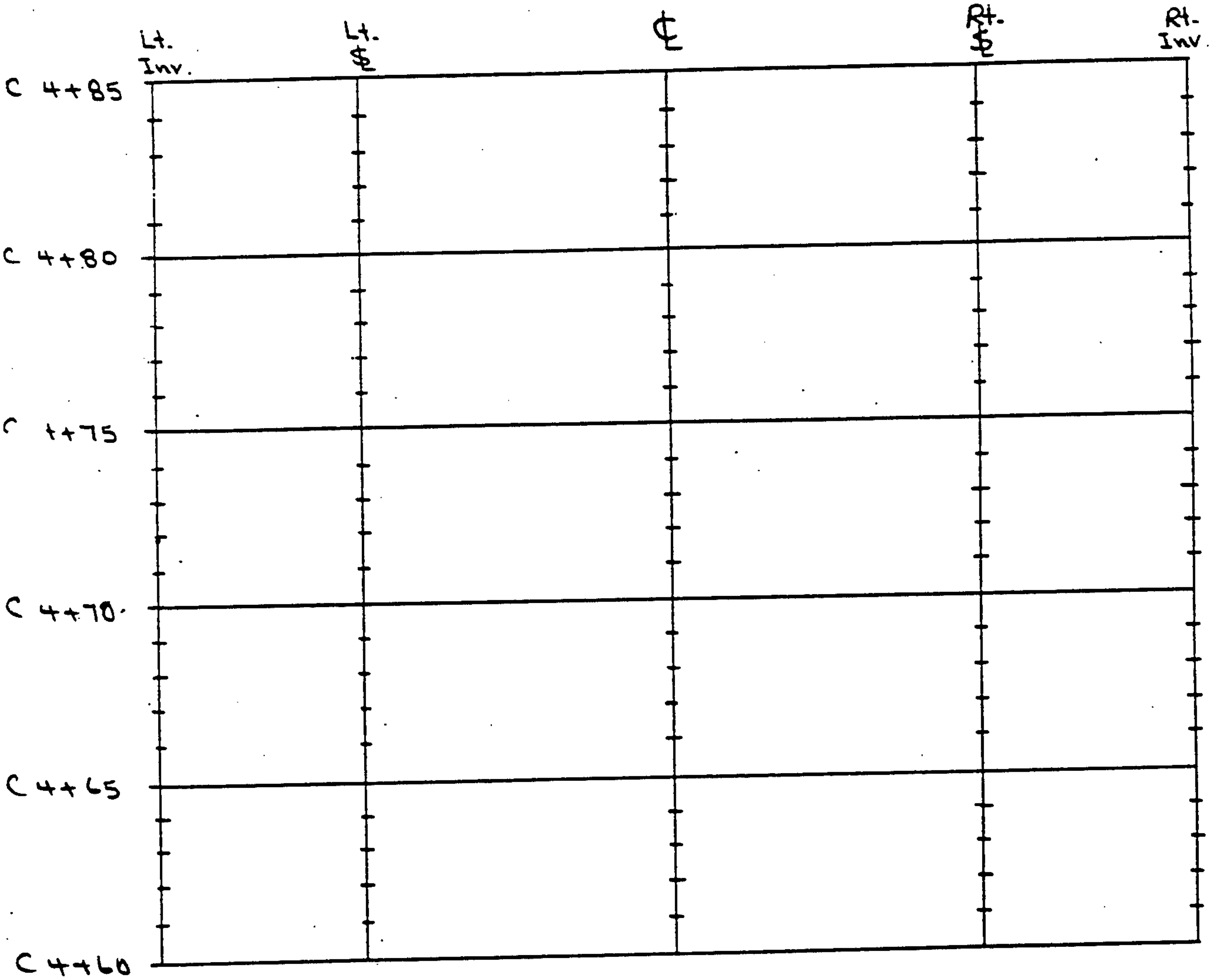
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 19	Of 21



Massive Rock

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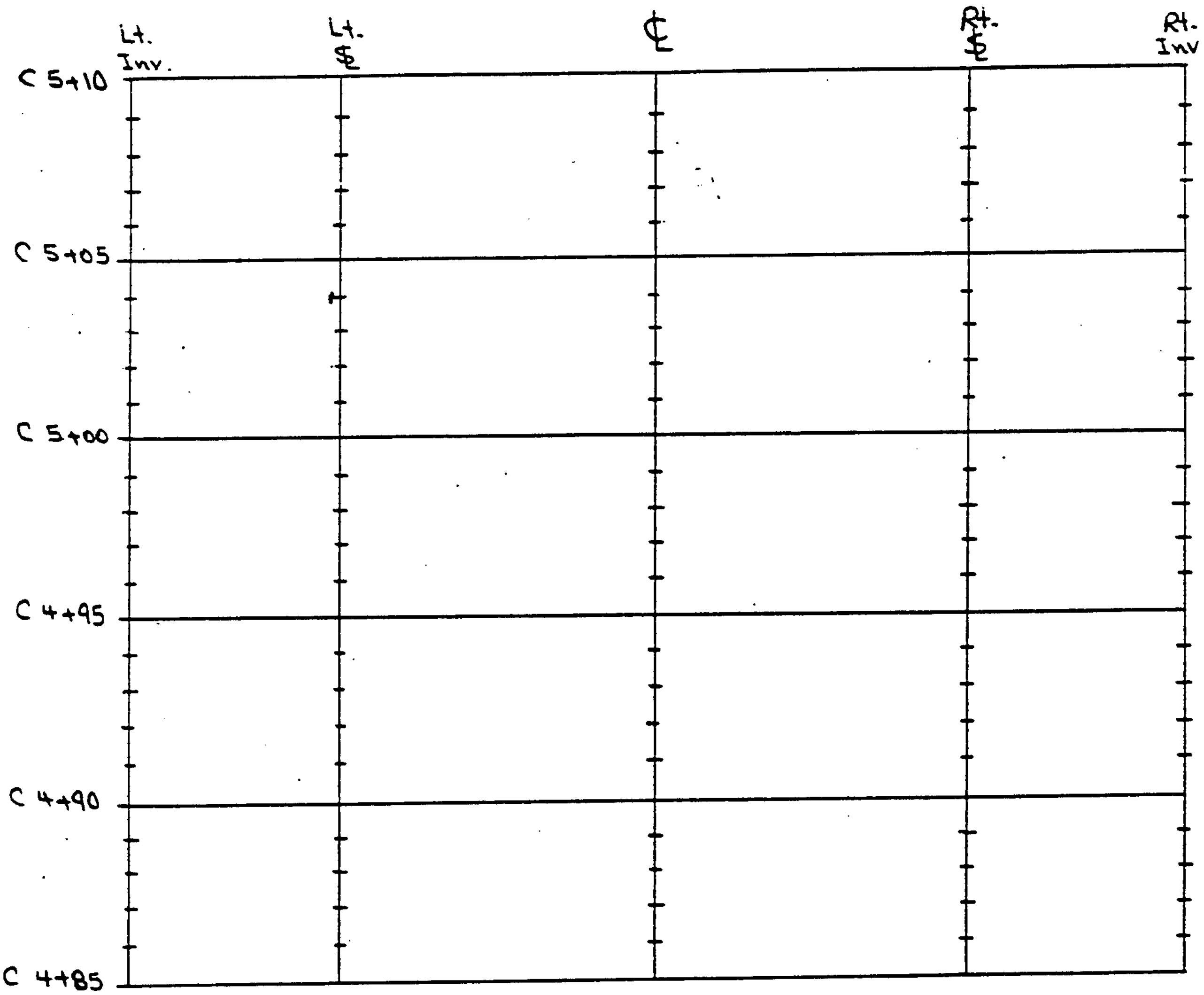
Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 20	Of 21



Massive Rock

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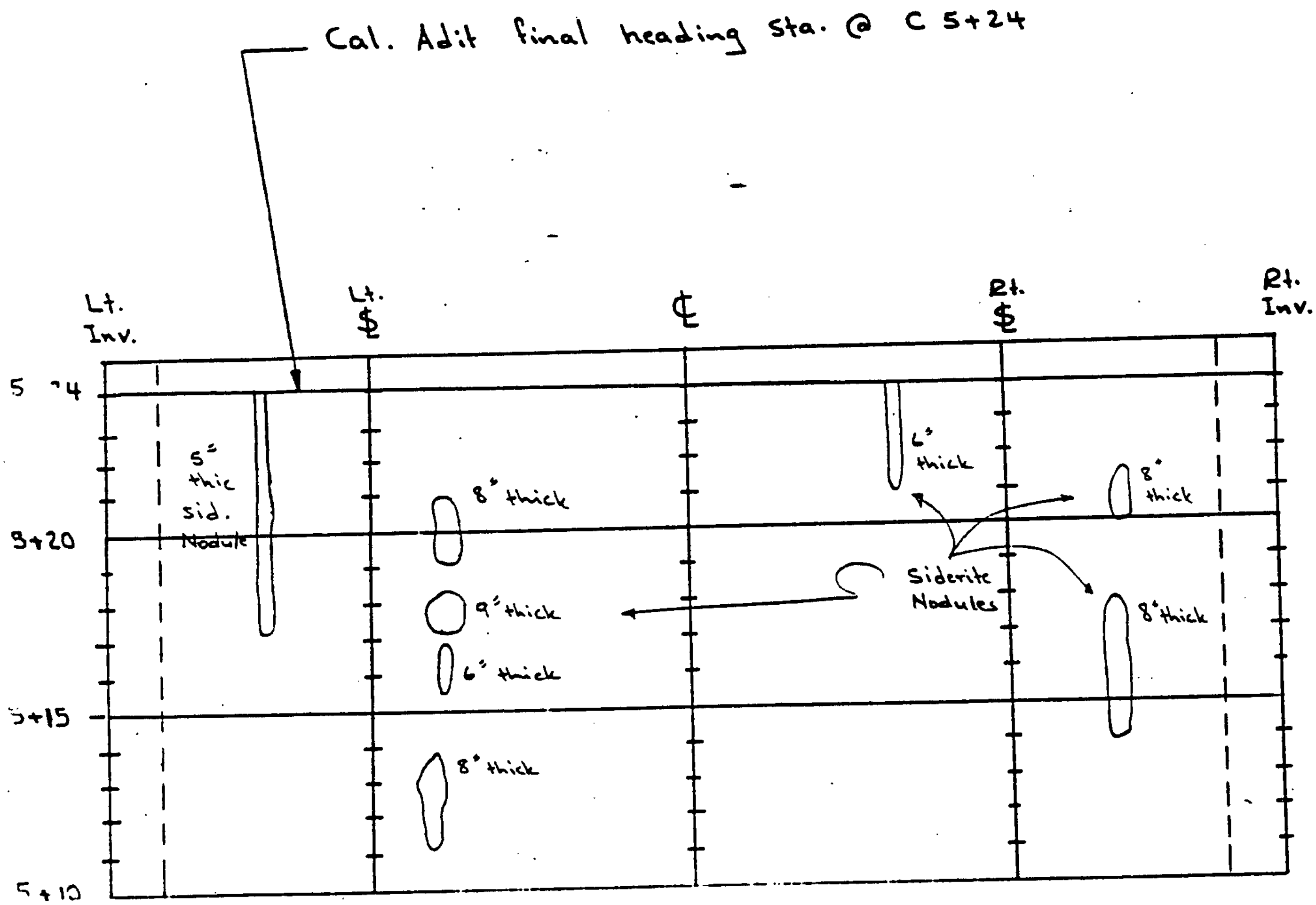
Project UTP		Computed	Date
Subject Cal. Adit - Geological Mapping		Checked	Date
Task Rock: New Providence Shale		Sheet 21	of 21



* Tunnel is wider by 3' from sta. C5+10 to C5+24

Appendix D

Photographs

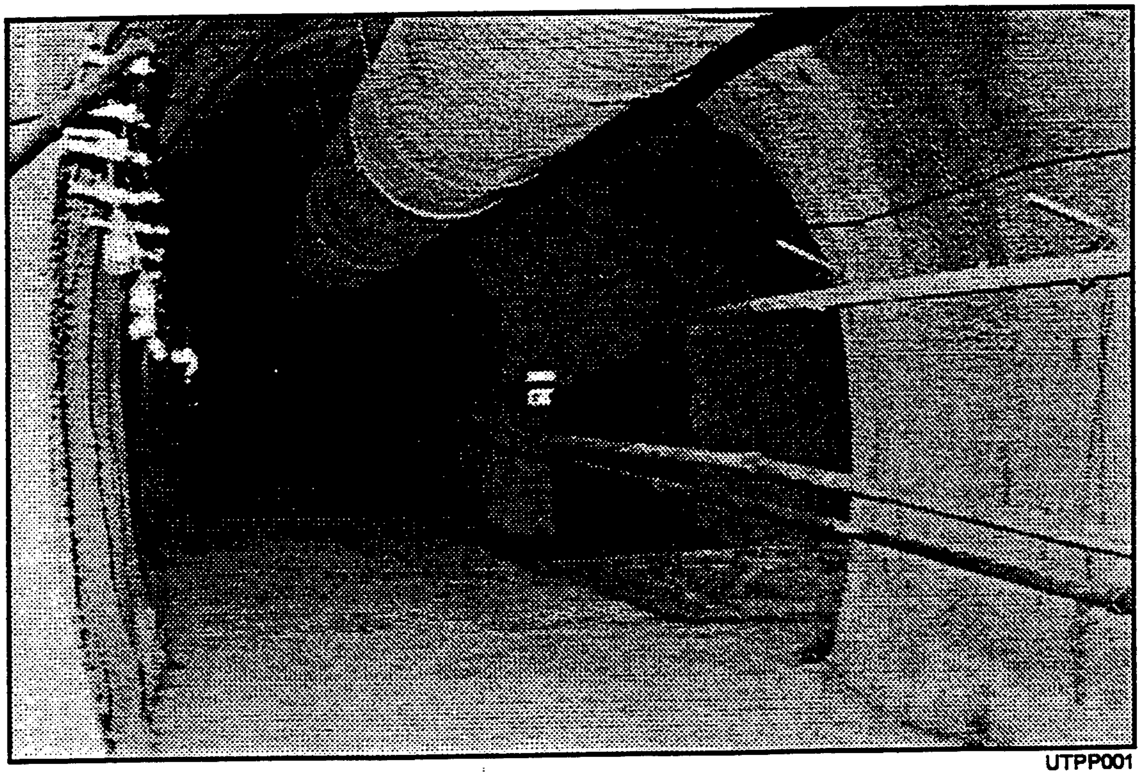

UTPP001

Figure D-1. Sump Bay.

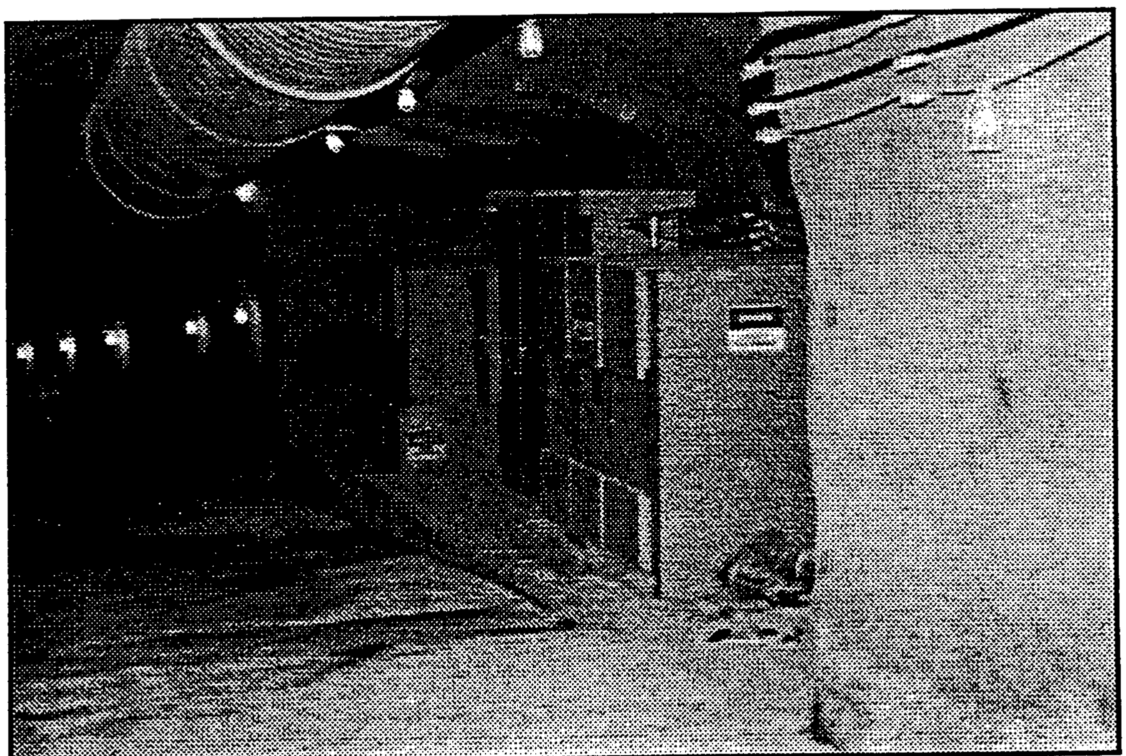
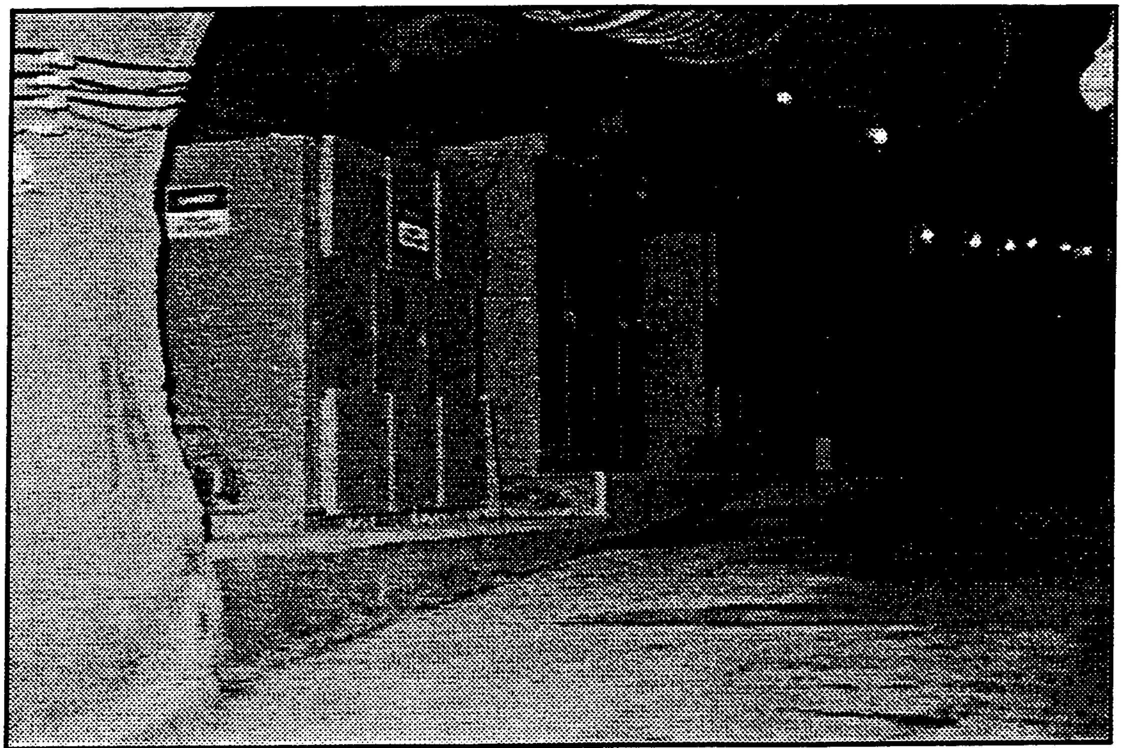
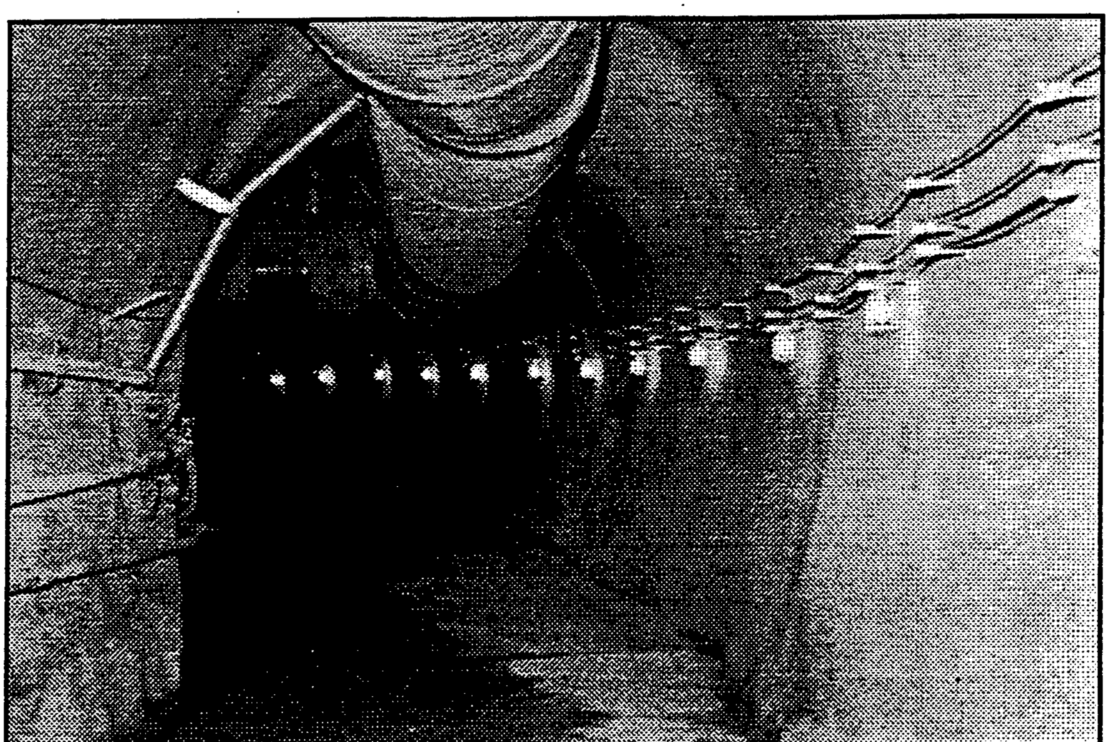

UTPP002

Figure D-2. Transformer bay (looking in).



UTPP003

Figure D-3. Transformer Bay.



UTPP004

Figure D-4. Intersection (Cal. Adit to Left).

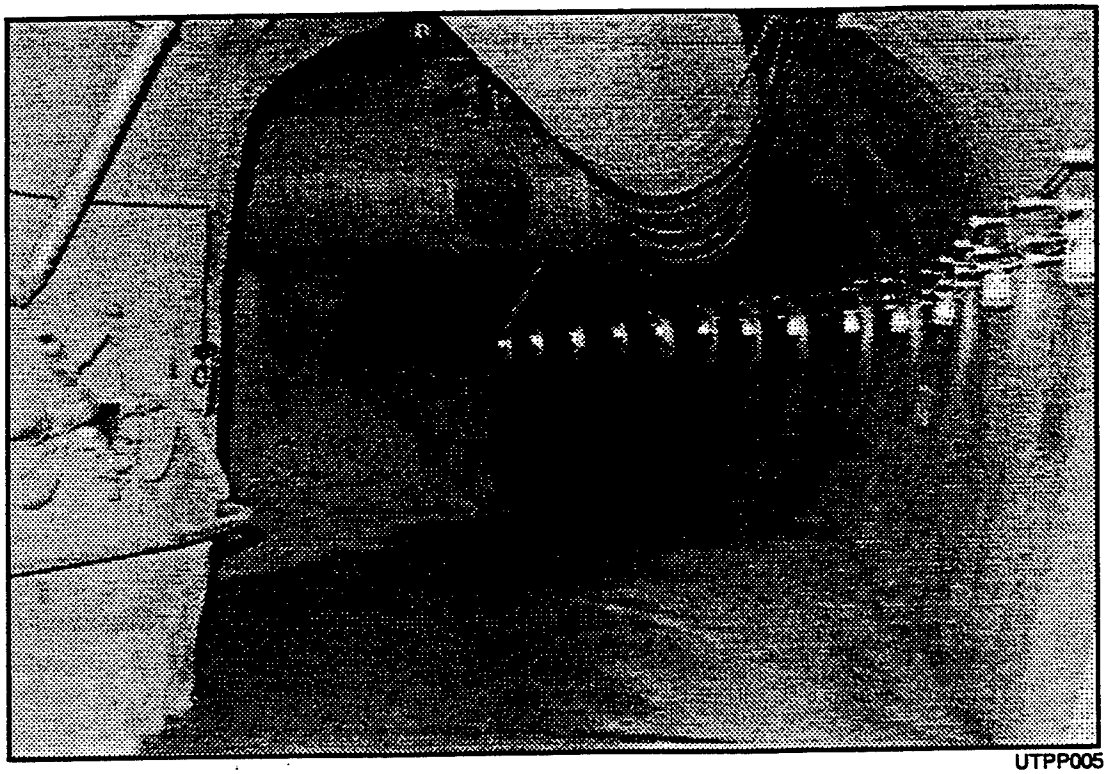

UTPP005

Figure D-5 Intersection (Cal. Adit to Left)

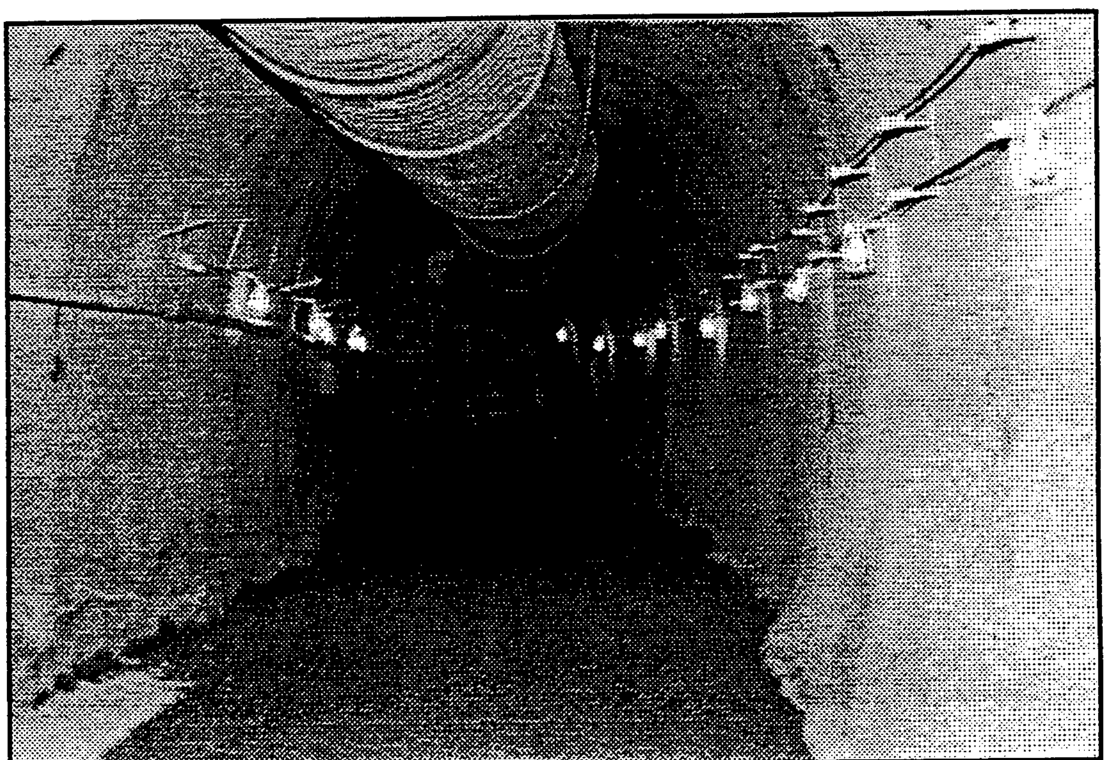
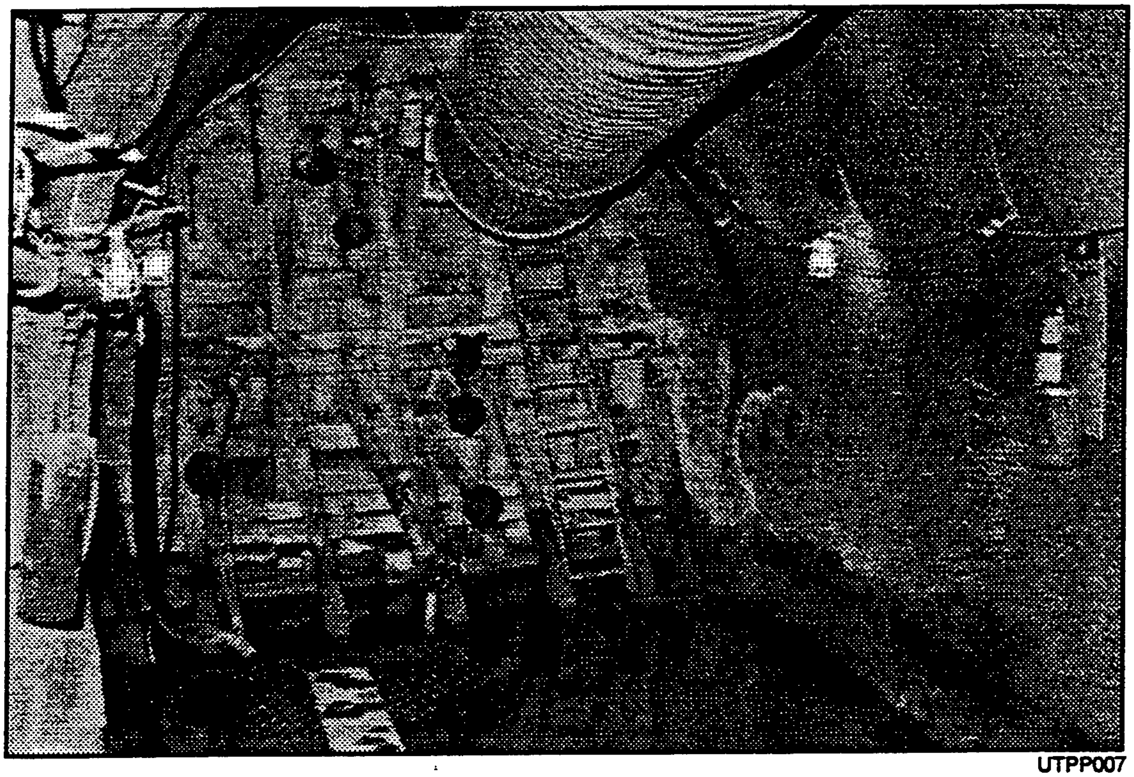
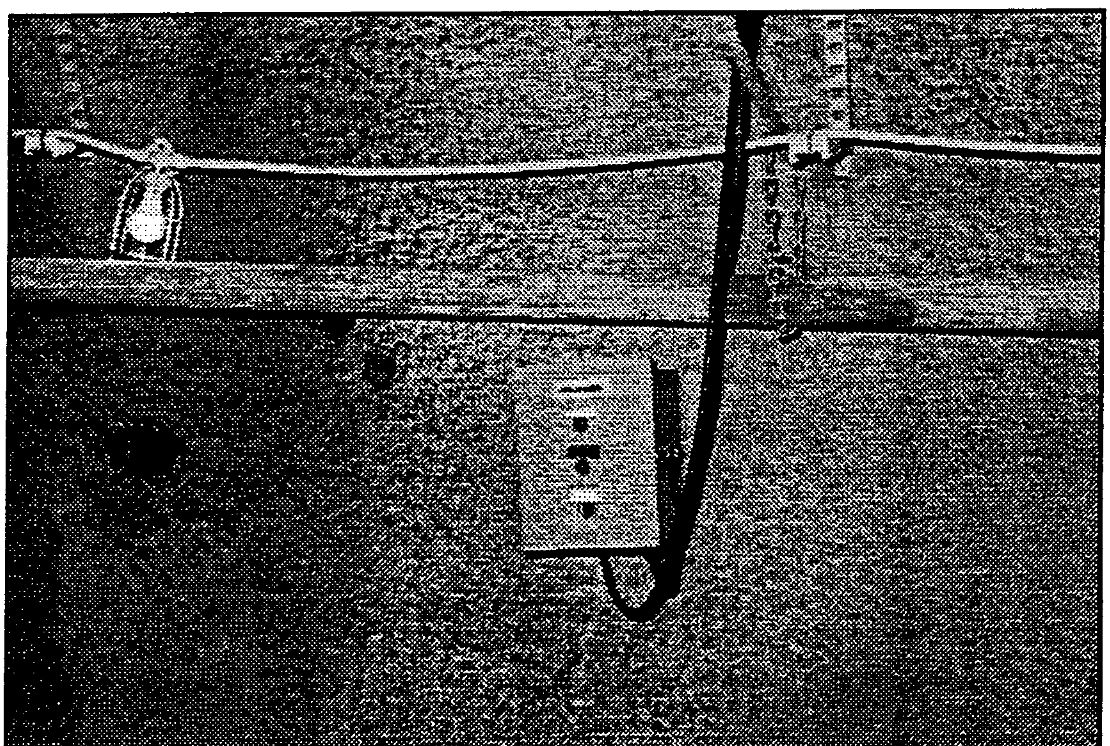

UTPP006

Figure D-6 Test Adit Looking Towards Plug



UTPP007

Figure D-7 Plug's Upper Face



UTPP008

Figure D-8 Typical Electric Switch for Water Pump at Bulkhead

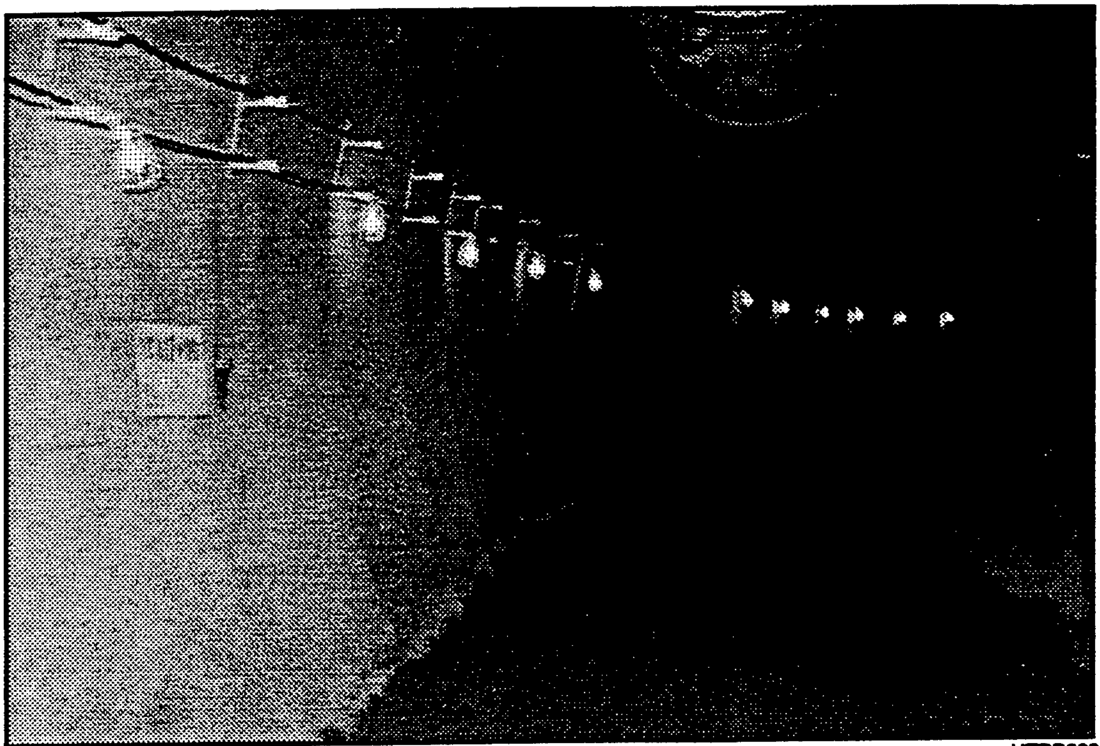

UTPP009

Figure D-9 Test Adit at Sta. 17+00

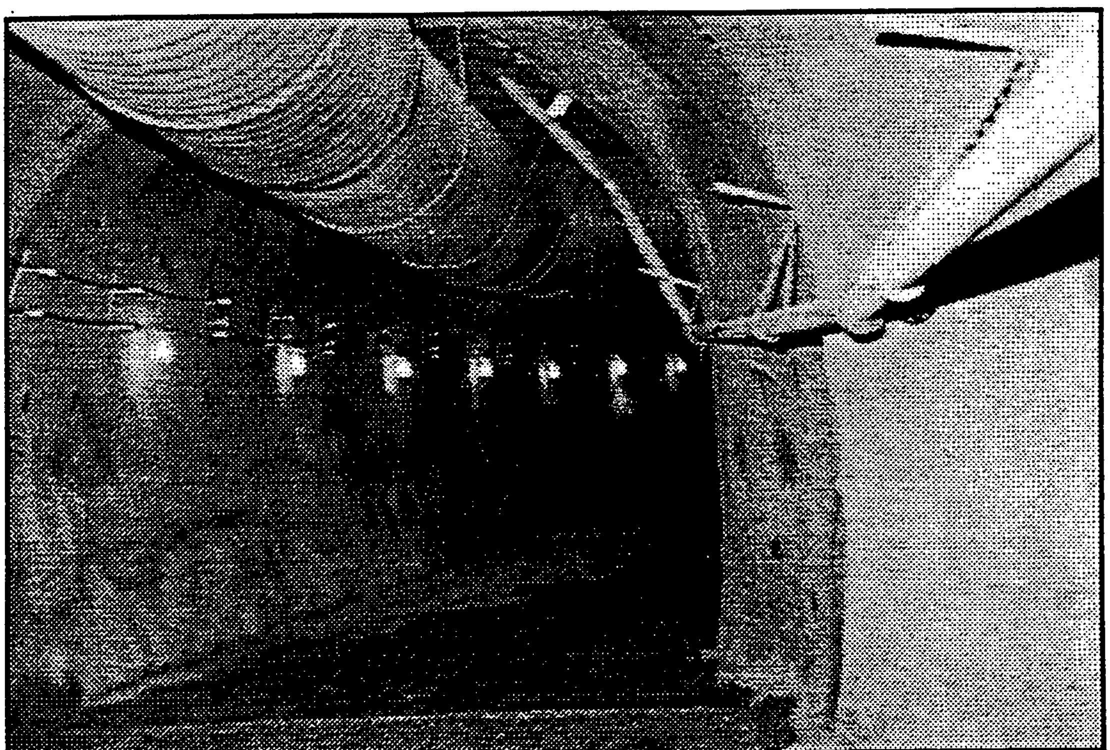

UTPP010

Figure D-10 Test Adit Intersection with Cal. Adit

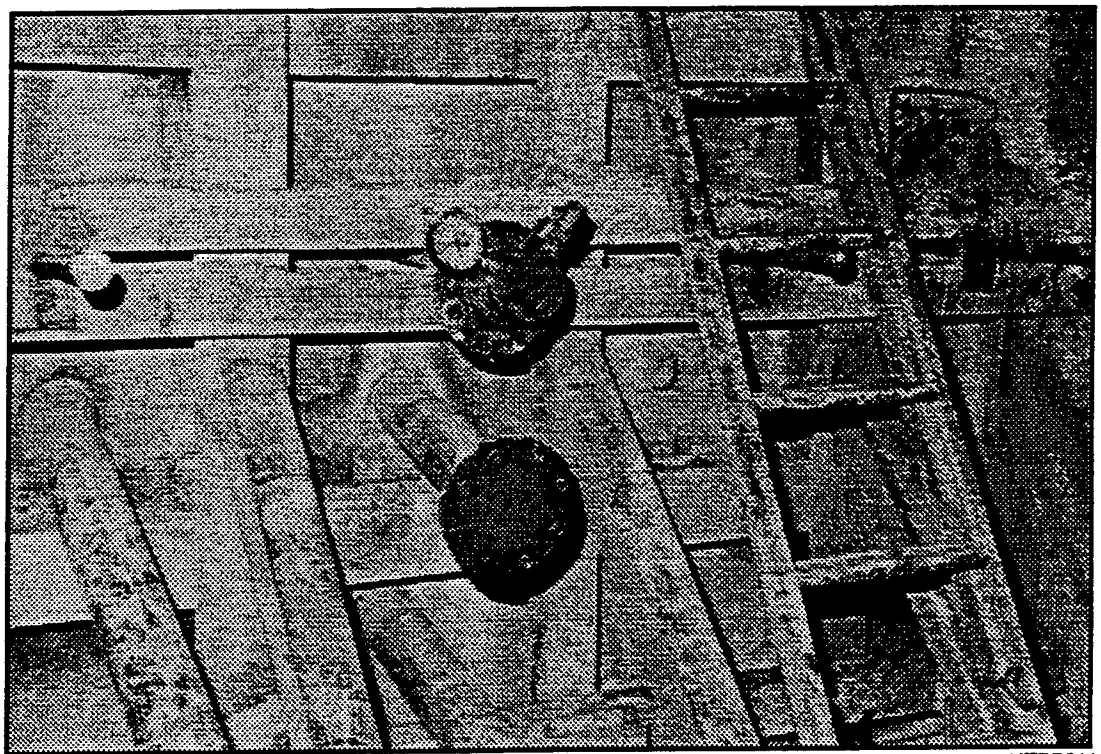

UTPP011

Figure D-11 Plug (Upper Bulkhead with Fill-Bleed Lines Shown)

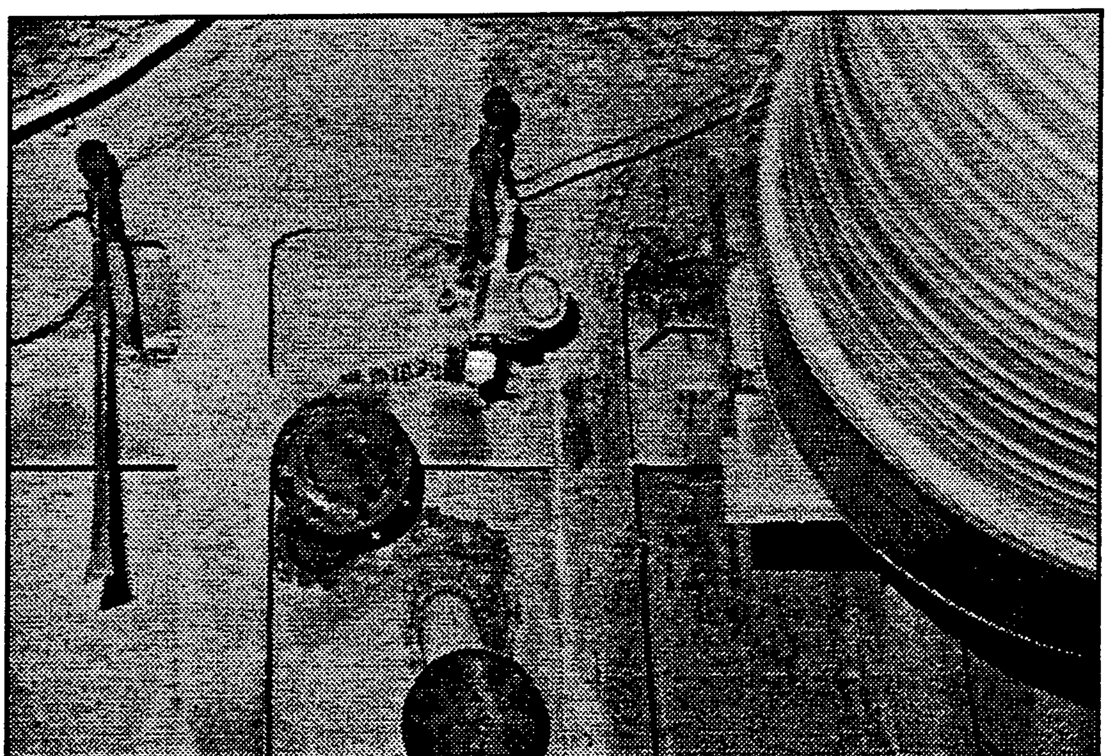

UTPP012

Figure D-12 Gas Monitor at Plug

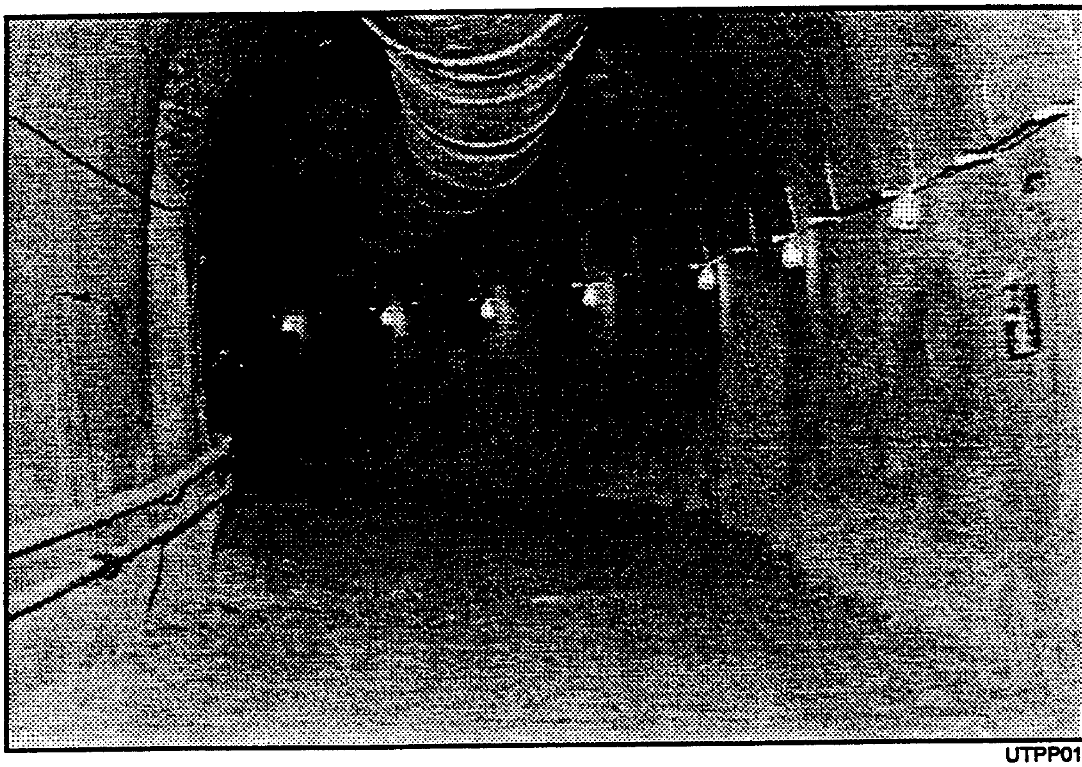


Figure D-13 Cal. Adit (Looking from Intersection)

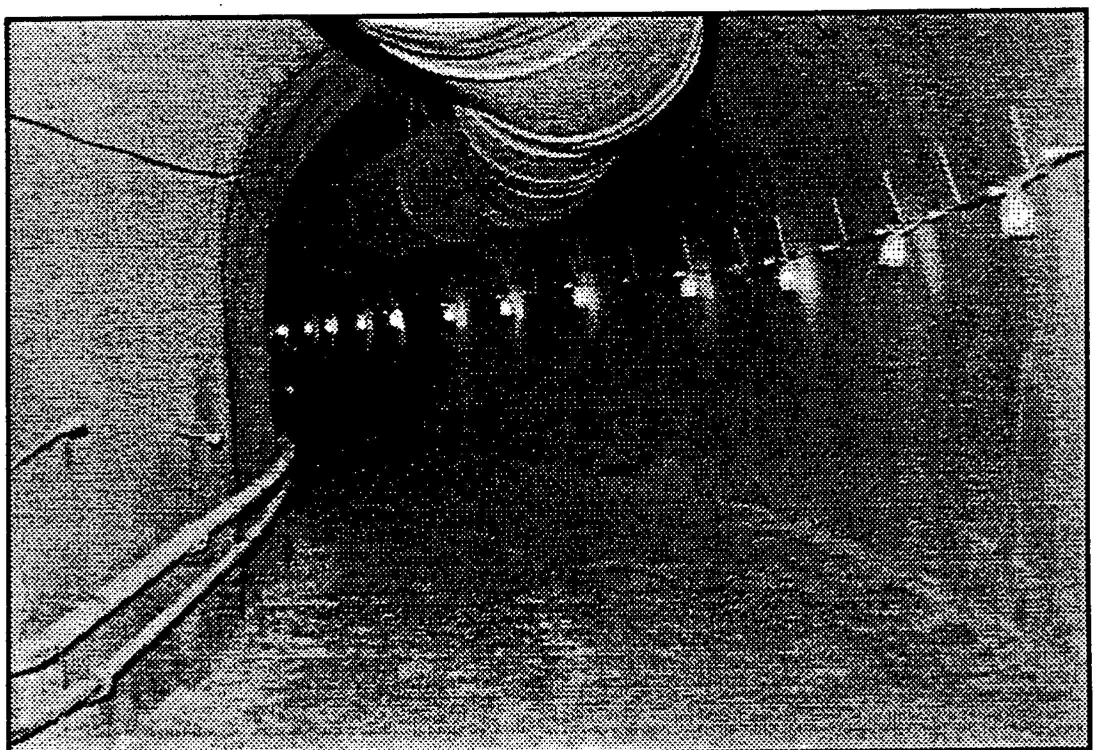
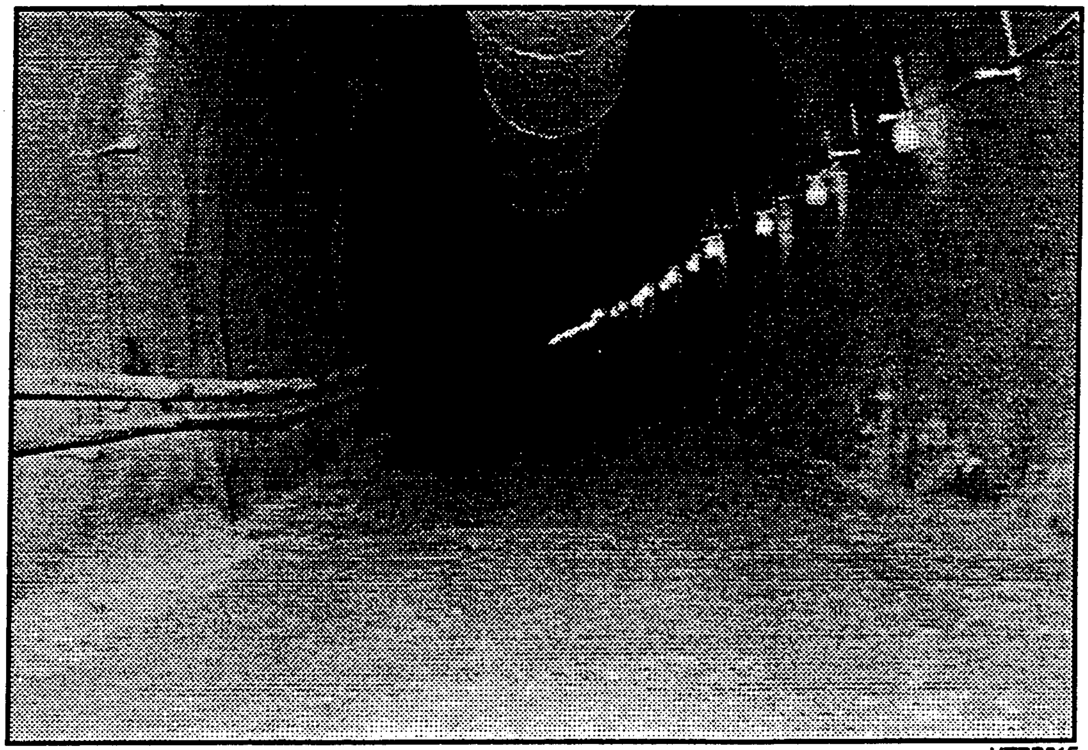
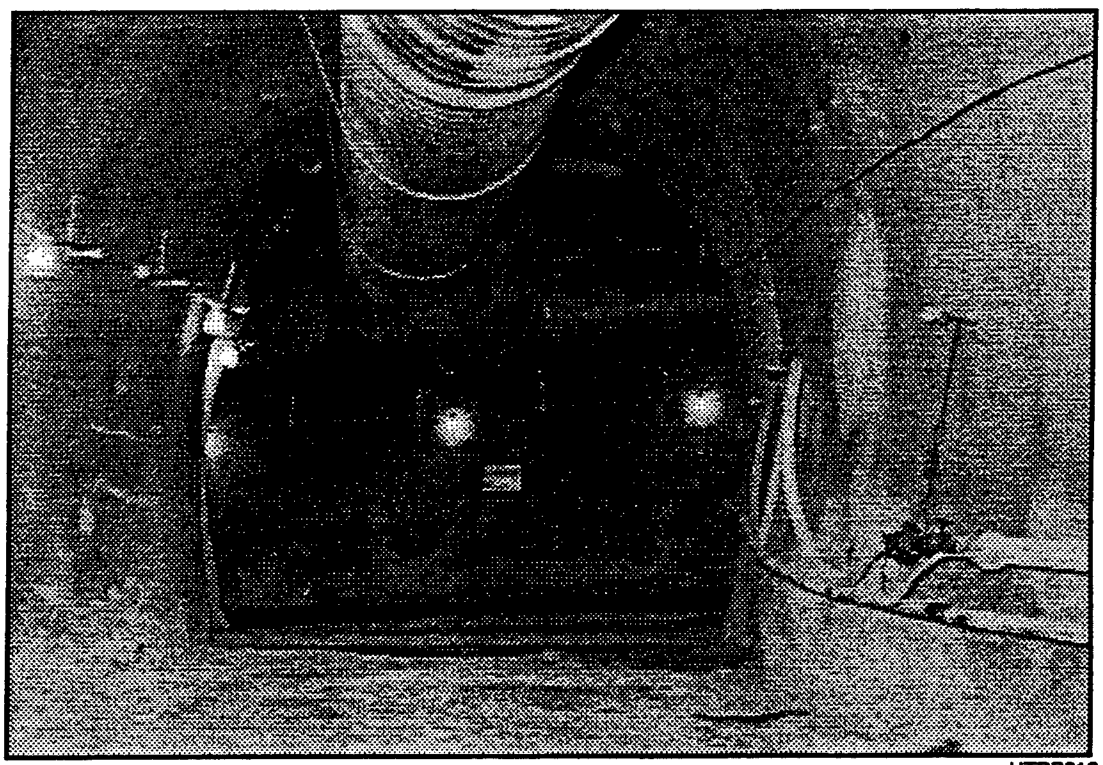


Figure D-14 Cal. Adit



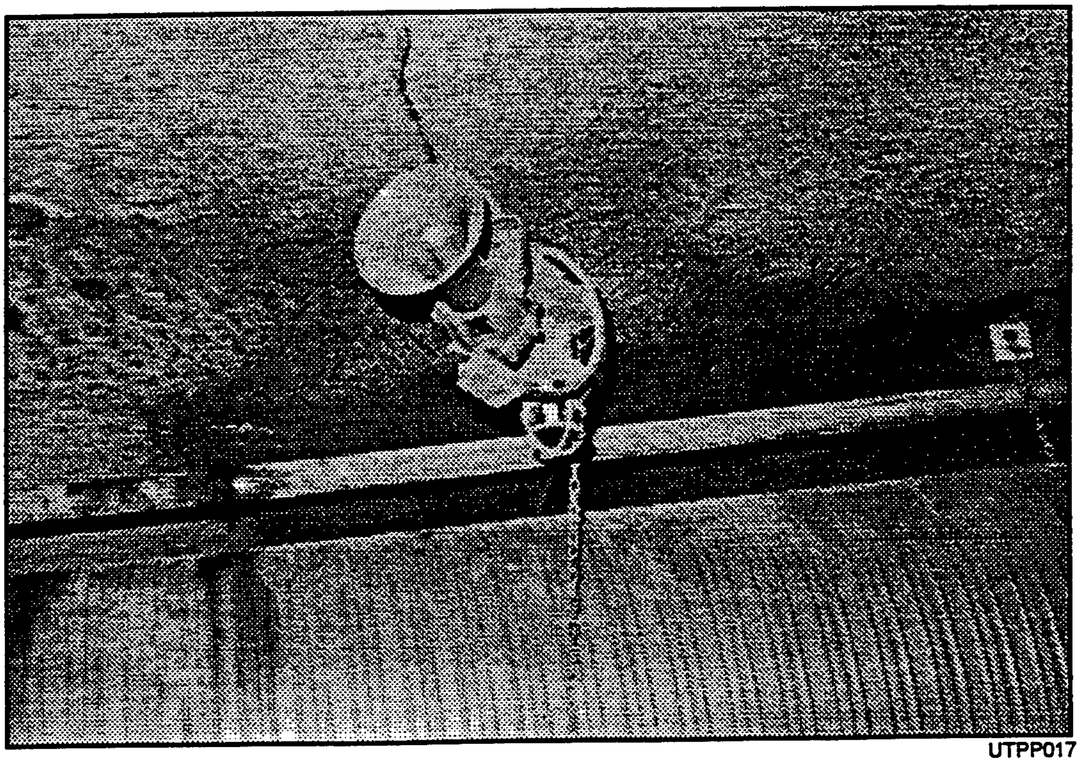
UTPP015

Figure D-15 Cal. Adit (Looking towards its Terminal Station)



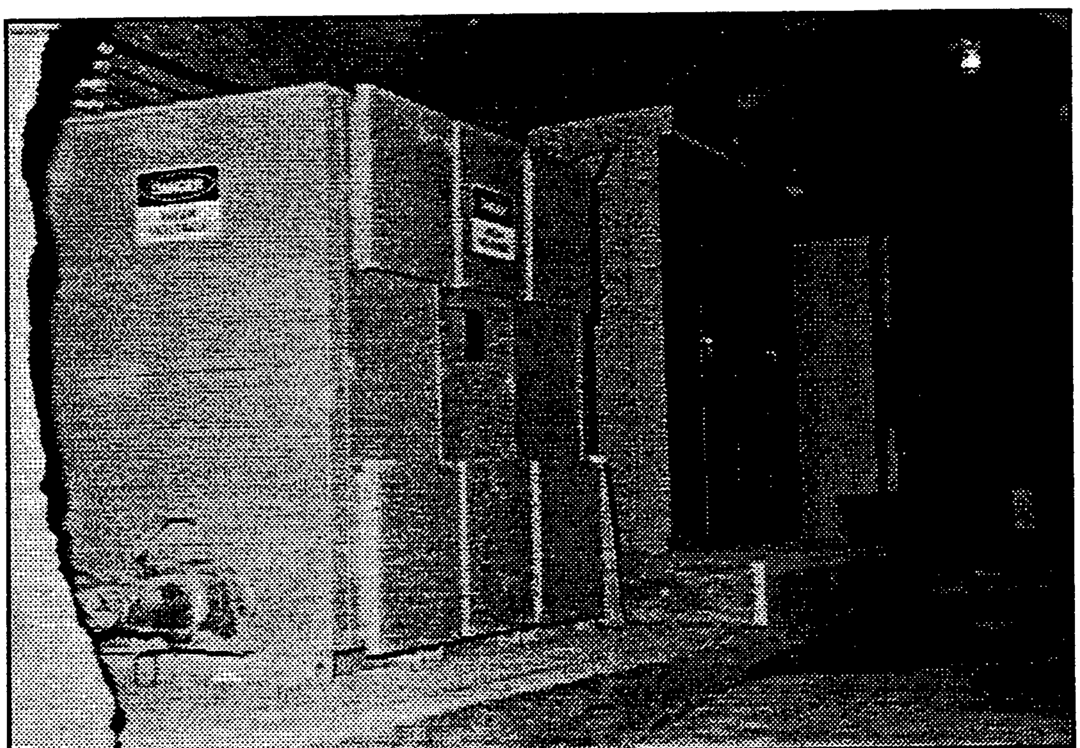
UTPP016

Figure D-16 Intersection (Looking from Cal. Adit)



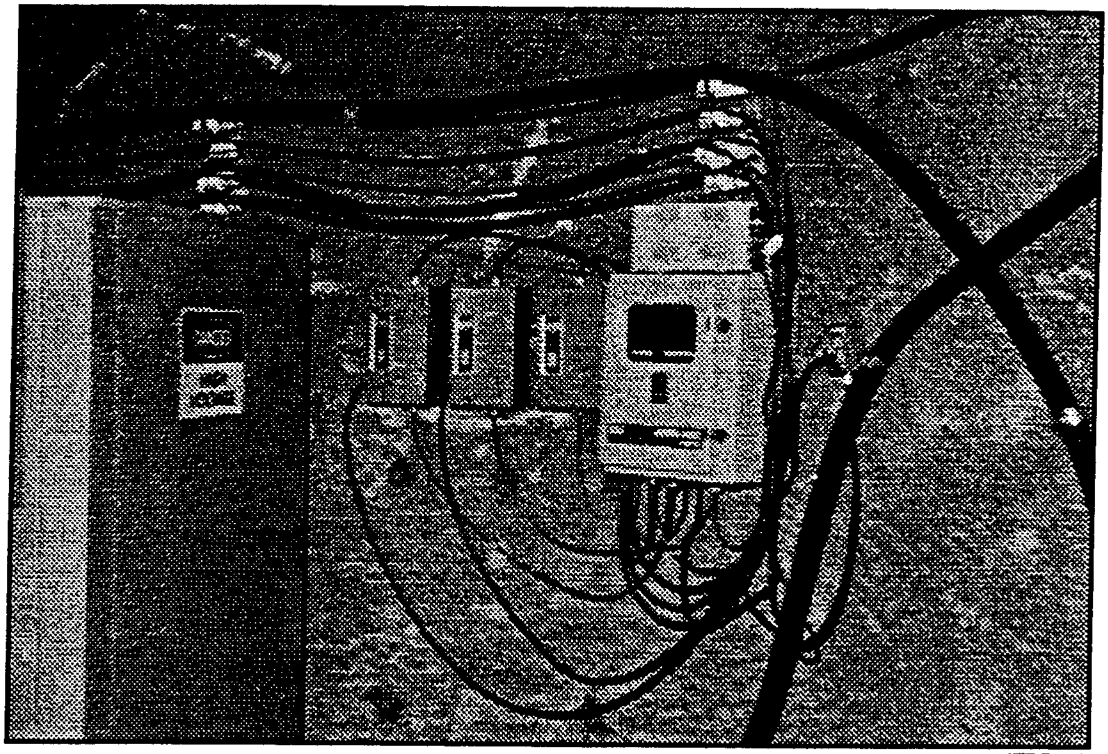
UTPP017

Figure D-17 Gas Warning/Monitor Siren and Light



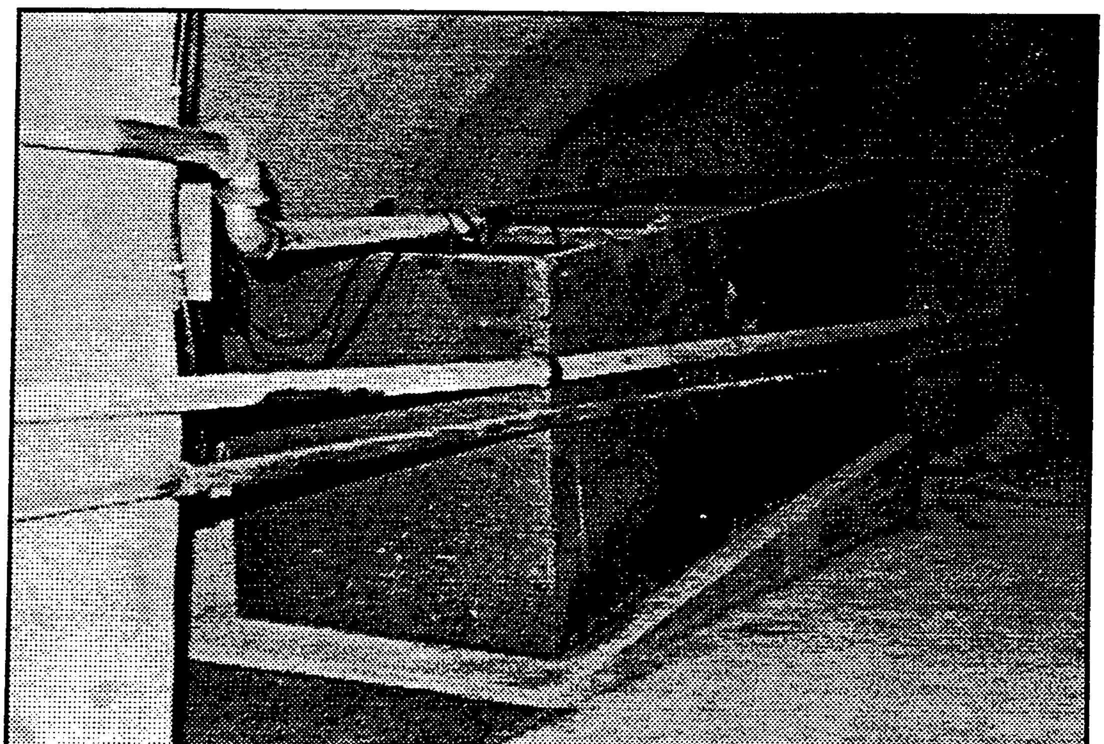
UTPP018

Figure D-18 Transfer Bay



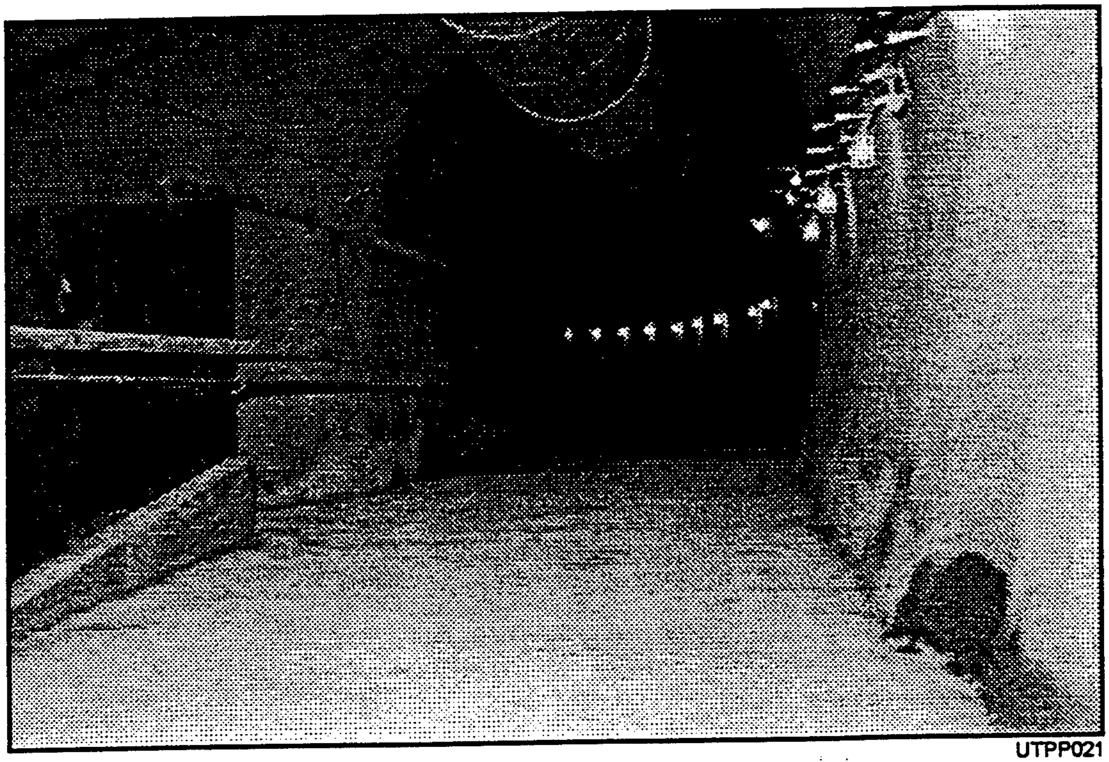
UTPP019

Figure D-19 Electric Controls and Gas Monitor Box



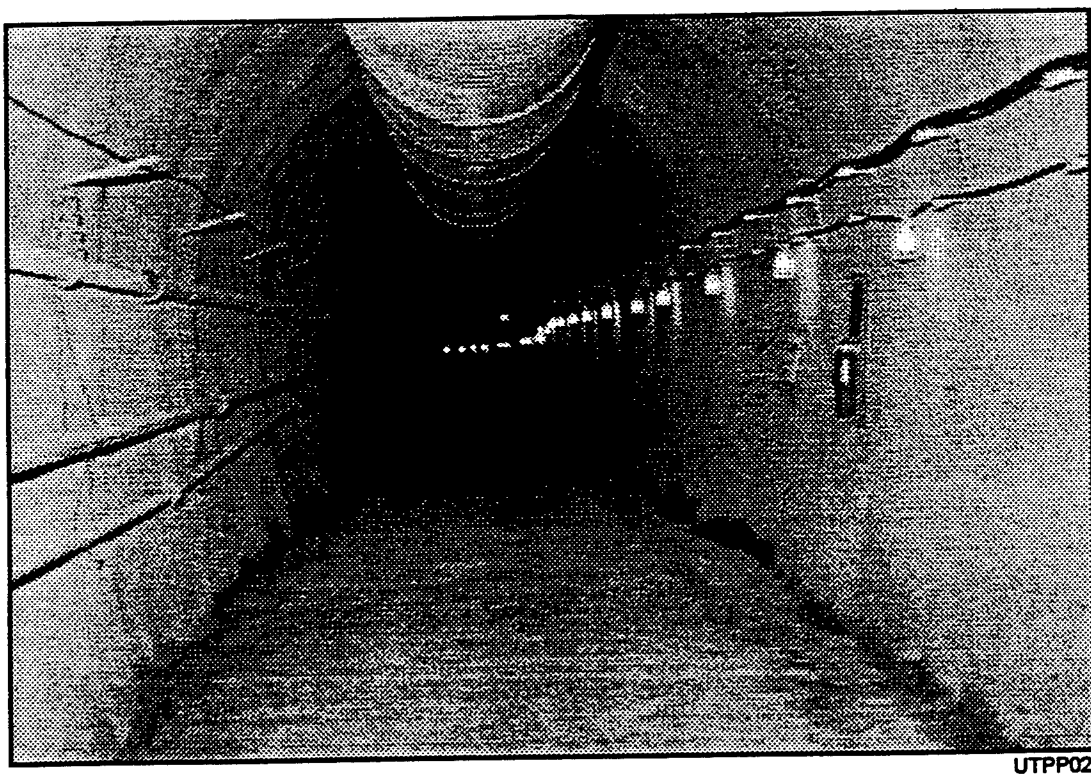
UTPP020

Figure D-20 Sump Tank at Sump Bay



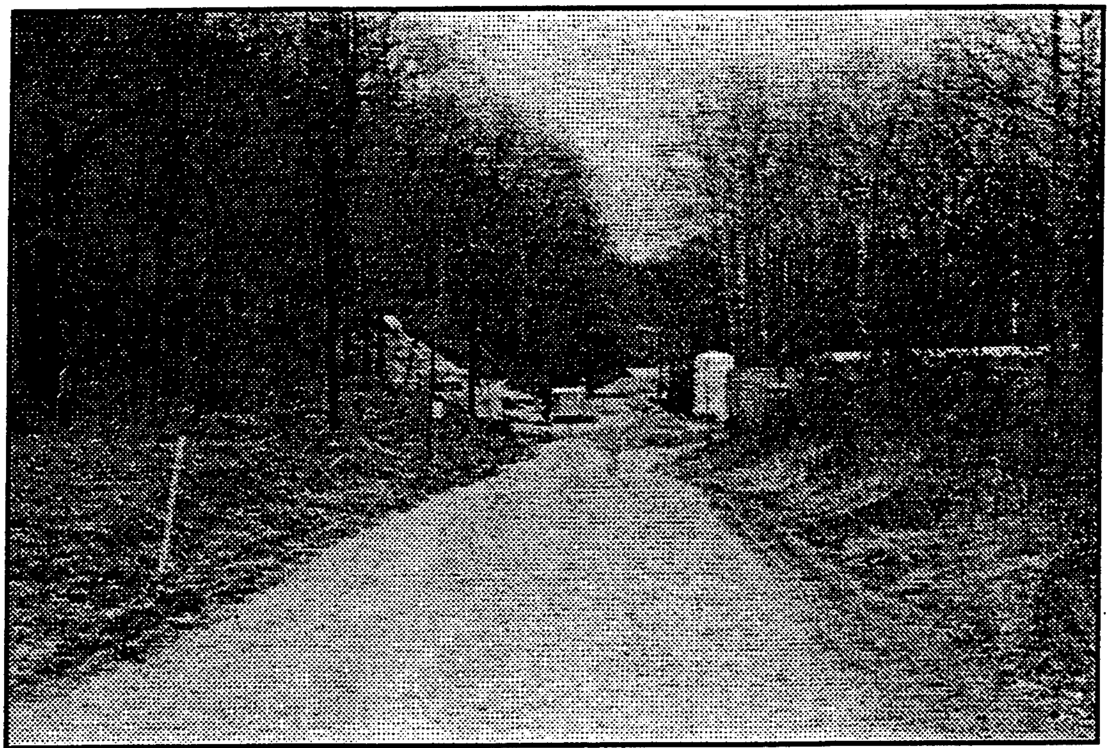
UTPP021

Figure D-21 Sump Bay



UTPP022

Figure D-22 Test Adit



UTPP023

Figure D-23 Access Road to Rodgers Hollow
(Portal on Left)

UTPP024

Figure D-24 Plug During Construction. Shown are Pressure
Grout Pipes with Gas Checks (Plates) and
4" Dia. Bleed Lines

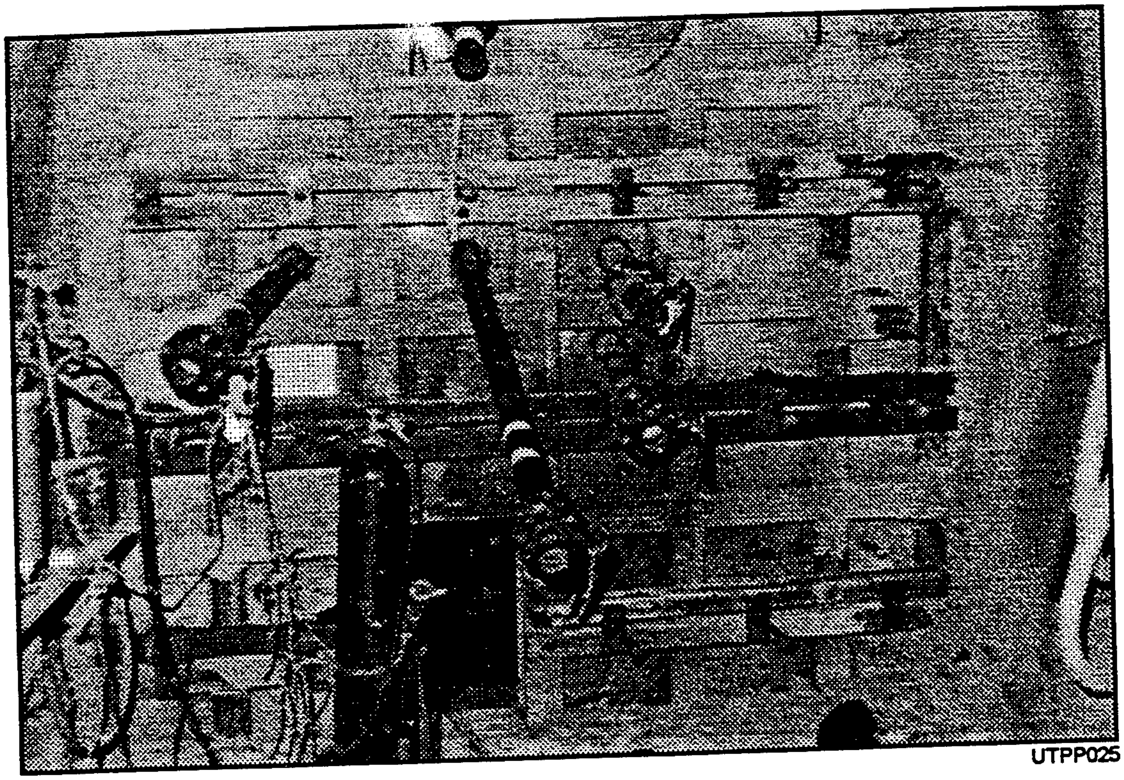


Figure D-25 Front (Upper) Bulkhead with Fill and Bleed Line Penetrations

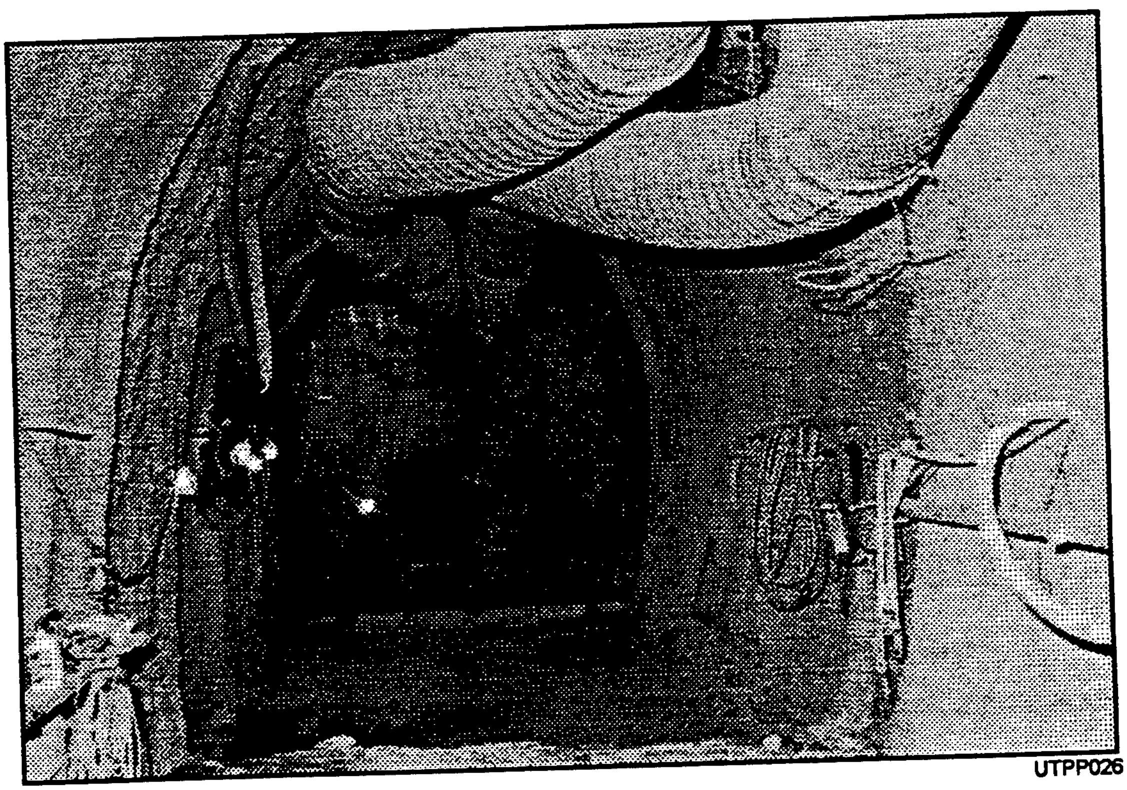
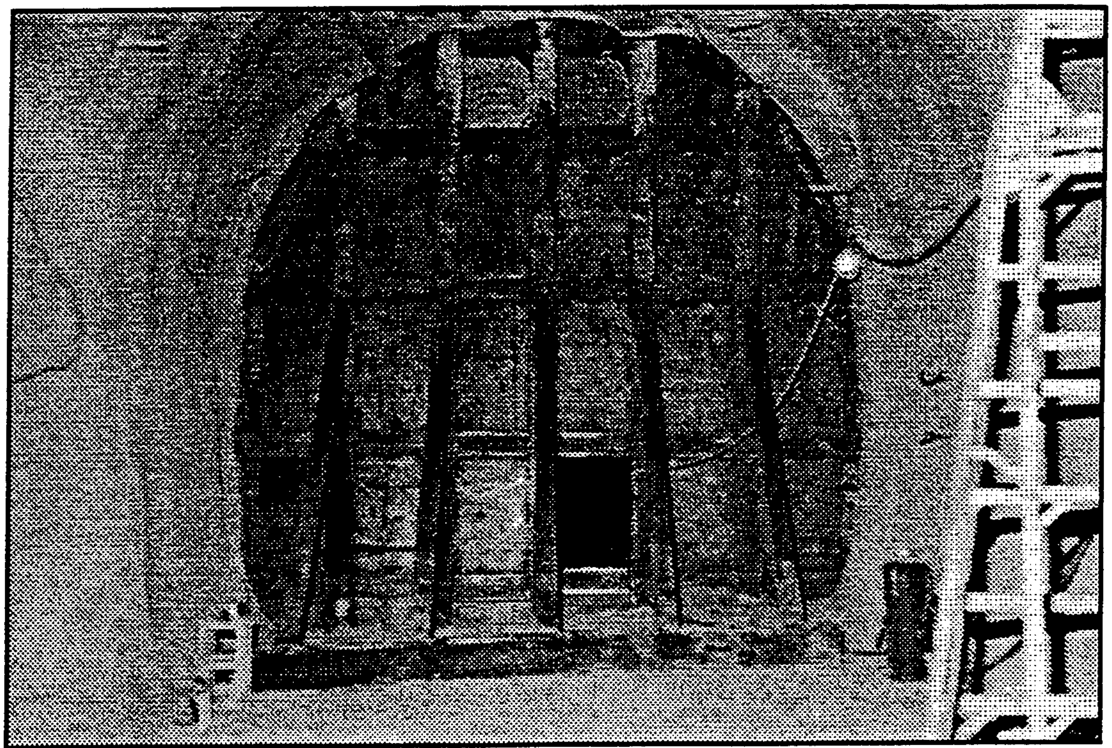
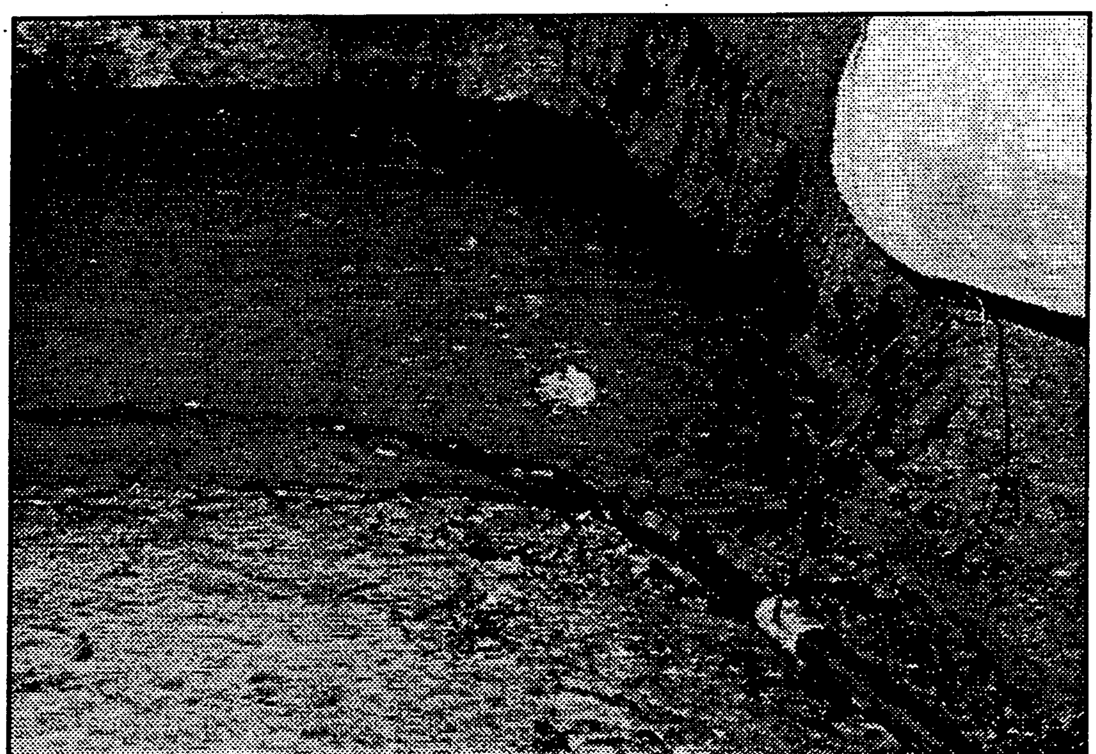


Figure D-26 Finished Rear (Lower) Bulkhead from Inside Plug



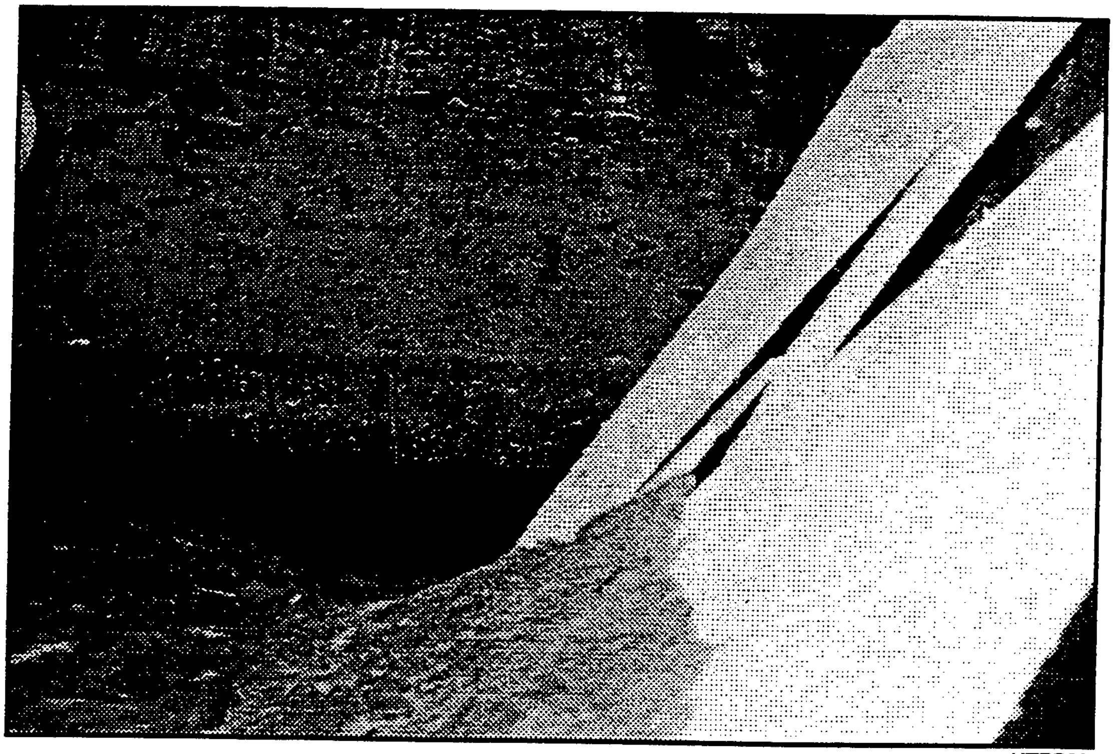
UTPP027

Figure D-27 Back of Lower Bulkhead Prior to completion.
Shown are Supports and Access Opening



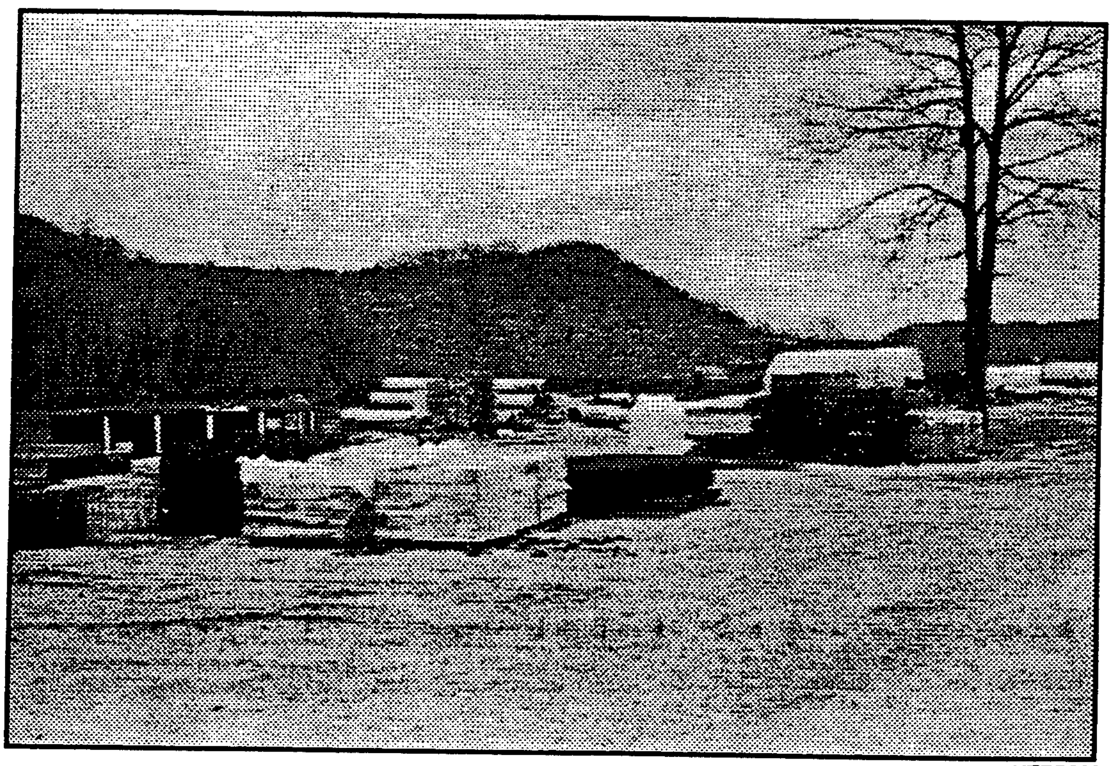
UTPP028

Figure D-28 Gas (Methane) Seepage at Sta. 18+50



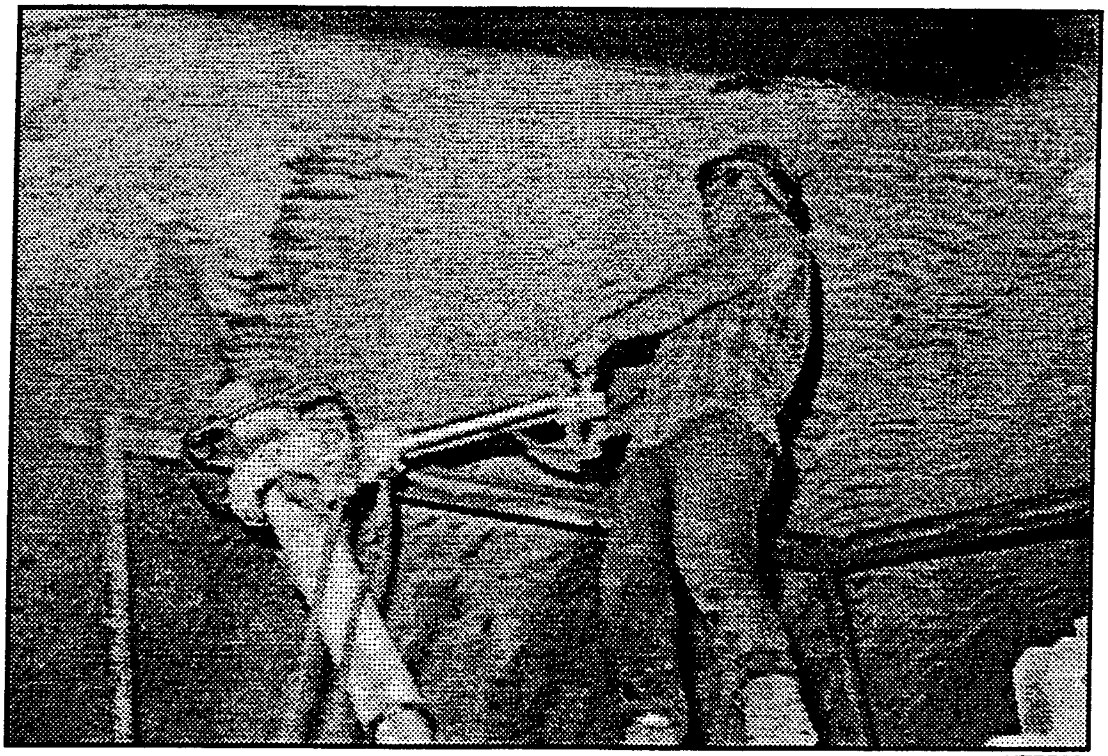
UTPP029

Figure D-29 Interface Bewteen New Providence Shale
(Top) and New Albany Shale (Bottom)
at Sta. 18+54



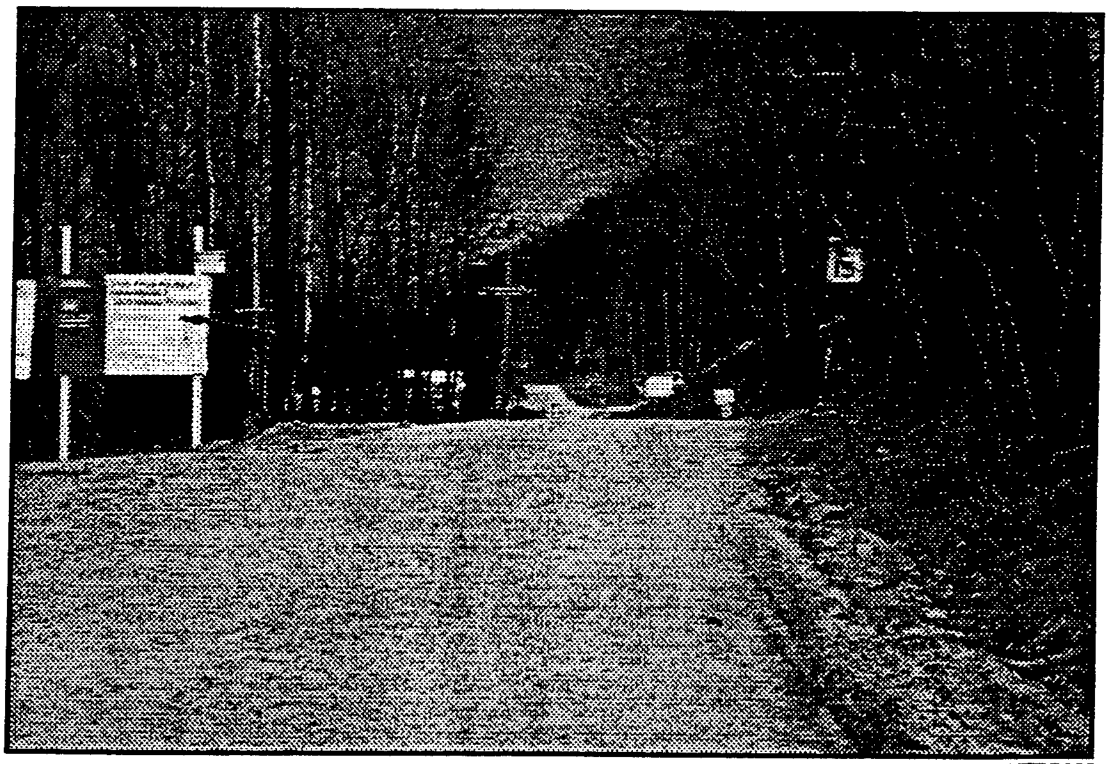
UTPP030

Figure D-30 Yard (Storage) Area on Site



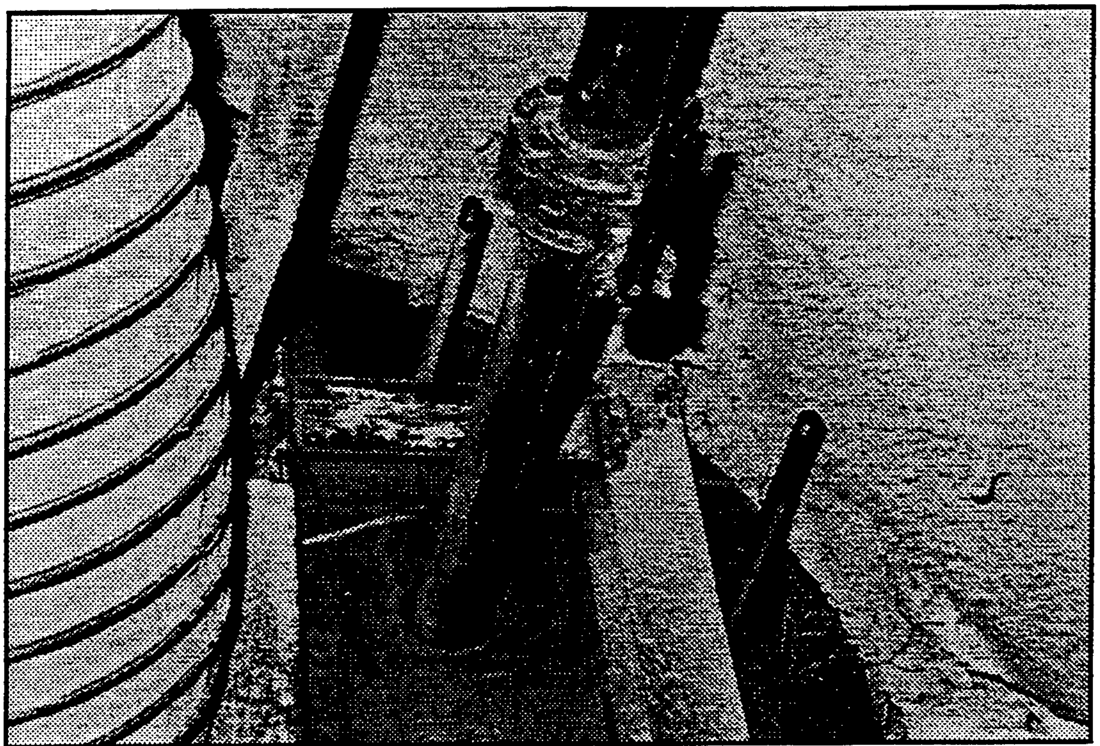
UTPP031

Figure D-31 Rock Bolt Installation



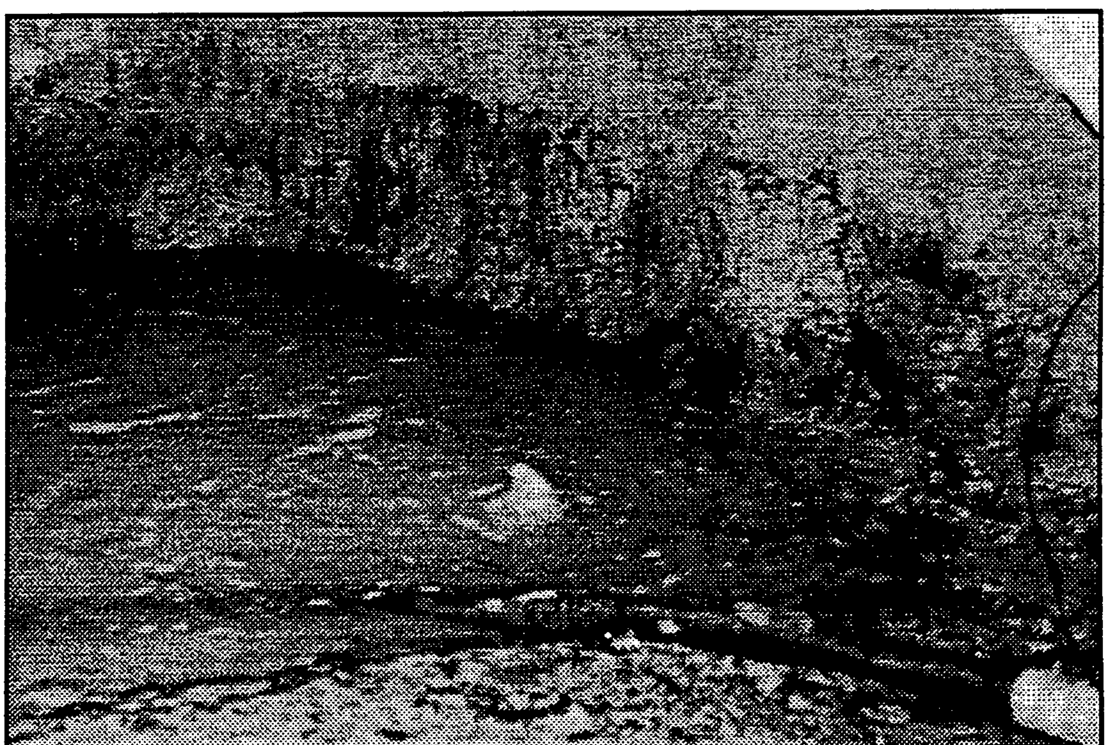
UTPP032

Figure D-32 Access Road to Site (Portal on Right)



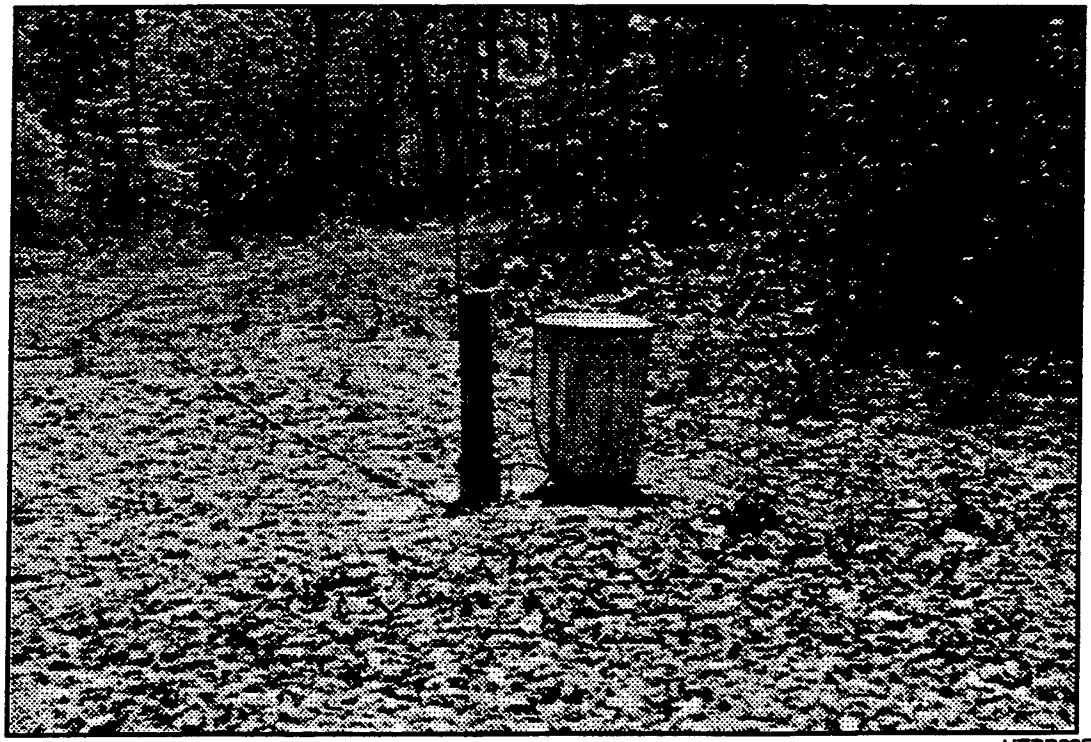
UTPP033

Figure D-33 Gas Bleed Line with Valve Penetrating
Upper (Front) Bulkhead



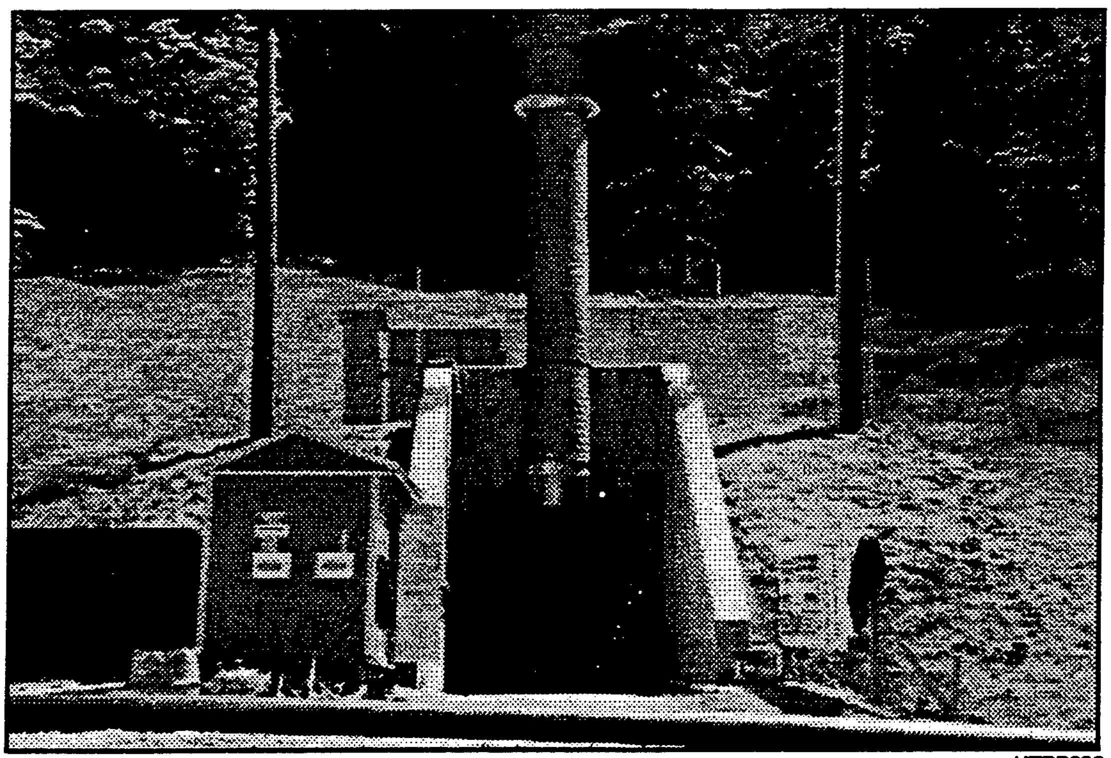
UTPP034

Figure D-34 Gas Seepage at Sta. 18+50



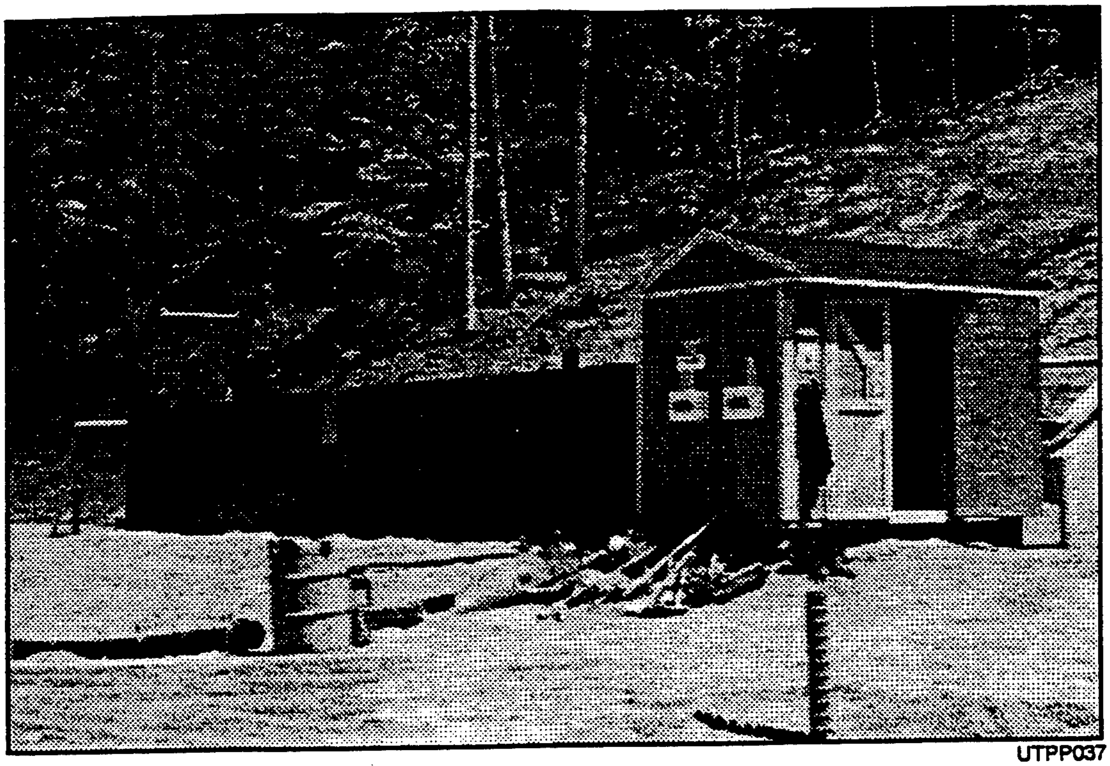
UTPP035

Figure D-35 Piezometer Monitoring Assembly P-1



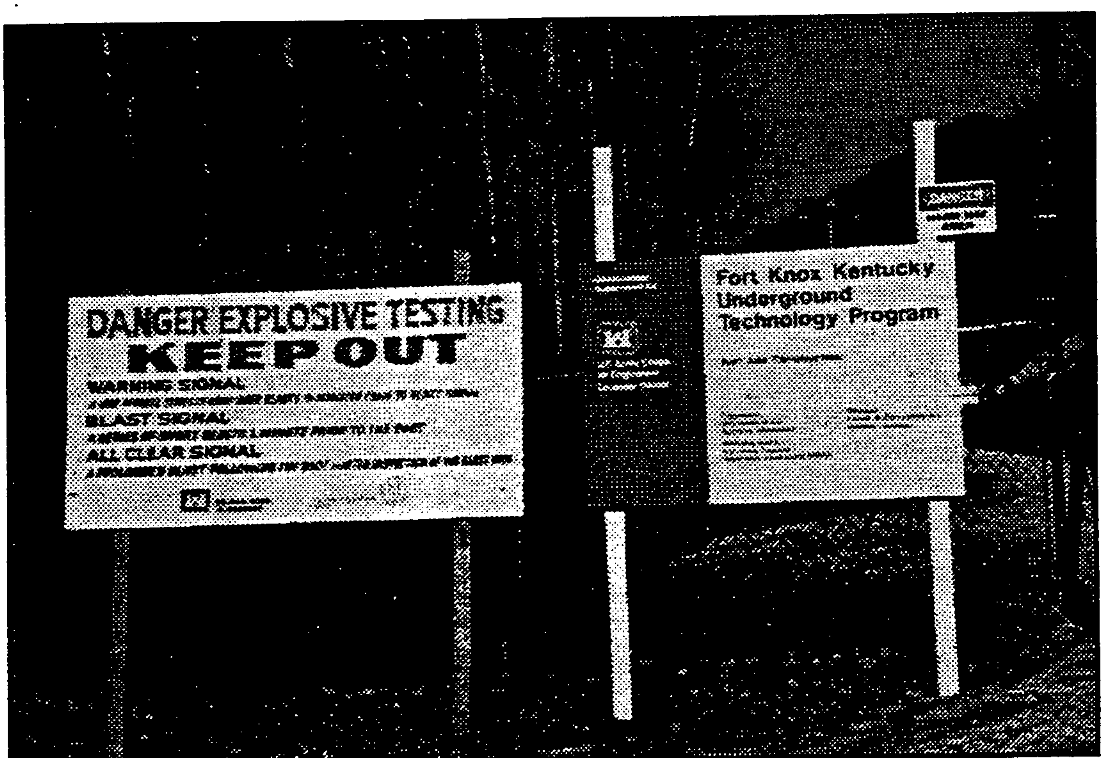
UTPP036

Figure D-36 Portal Showing Final Vent Exhaust and Electrical Substation on Top (Stack Removed Recently for Safety Reasons)



UTPP037

Figure D-37 Sump Tanks Outside Tunnel Delivering Water Pumped Out of Tunnel to Dewatering Line Going to Salt River



UTPP038

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